

(12) **United States Patent**  
**Hermey et al.**

(10) **Patent No.:** **US 11,811,154 B2**  
(45) **Date of Patent:** **Nov. 7, 2023**

(54) **COMPACT PROTECTIVE CABLE CONDUIT FOR CLEAN ROOM APPLICATIONS AND ENCASING UNIT AND ARRANGEMENT WITH SUPPORT CHAIN FOR SAME**

(58) **Field of Classification Search**  
CPC ..... H01R 13/422  
See application file for complete search history.

(71) Applicant: **IGUS GMBH**, Cologne (DE)

(56) **References Cited**

(72) Inventors: **Andreas Hermey**, Hennef (DE);  
**Dominik Barten**, Meckenheim (DE)

U.S. PATENT DOCUMENTS

(73) Assignee: **IGUS GMBH**, Cologne (DE)

3,160,175 A 12/1964 Laemmle  
6,573,451 B2 6/2003 Komiya et al.  
(Continued)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 292 days.

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **17/310,061**

CN 1409452 4/2003  
CN 1846084 10/2006  
(Continued)

(22) PCT Filed: **Jan. 14, 2020**

OTHER PUBLICATIONS

(86) PCT No.: **PCT/EP2020/050842**  
§ 371 (c)(1),  
(2) Date: **Jul. 14, 2021**

English translation of Office Action from related Chinese Appln. No. 202080014446.3, dated Nov. 16, 2022.  
(Continued)

(87) PCT Pub. No.: **WO2020/148300**  
PCT Pub. Date: **Jul. 23, 2020**

*Primary Examiner* — Neil Abrams  
(74) *Attorney, Agent, or Firm* — Grossman, Tucker, Perreault & Pfleger, PLLC

(65) **Prior Publication Data**  
US 2022/0149556 A1 May 12, 2022

(57) **ABSTRACT**

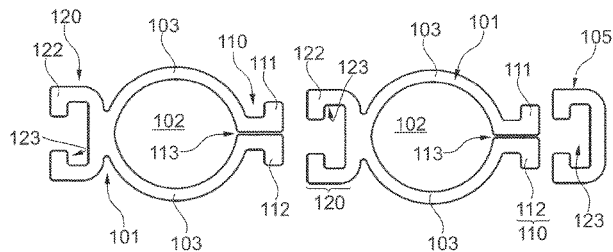
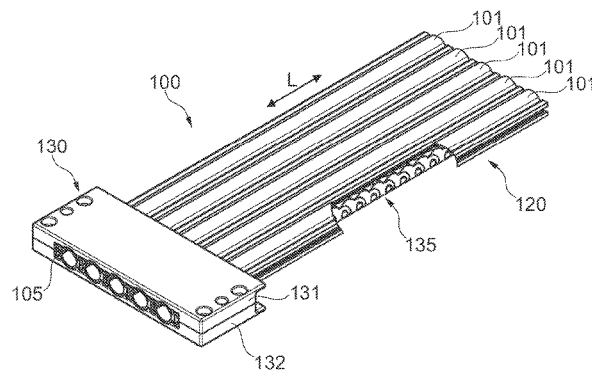
(30) **Foreign Application Priority Data**

Jan. 14, 2019 (DE) ..... 20 2019 100 169.0  
Jun. 11, 2019 (DE) ..... 20 2019 103 276.6

A protective cable conduit for lines in a clean room application, with a flexible encasement which is movable back and forth for routing a line. Each receptacle extends in channel-like fashion from a first end to a second end. The encasement comprises at least one encasing unit, which forms the at least one receptacle for a line. The encasing unit has a first fastening strip on one longitudinal side and a second fastening strip on the other longitudinal side. The first and the second fastening strip are designed for releasable connection by interlocking engagement and/or frictional engagement, for example with a cooperating hook profile and claw profile, and are connectable to one another in a connection direction transverse to the longitudinal direction. A plurality of encasing units can thus be fastened to one another releasably using mating fastening strips by connecting the fastening strips in a connection direction  
(Continued)

(51) **Int. Cl.**  
**F16L 3/015** (2006.01)  
**H01R 13/422** (2006.01)  
(Continued)

(52) **U.S. Cl.**  
CPC ..... **H01R 13/422** (2013.01); **F16G 13/16** (2013.01); **F16L 3/015** (2013.01); **F16L 3/26** (2013.01);  
(Continued)



transverse to the longitudinal direction. An arrangement of a protective cable conduit with support chains, wherein each support chain is routed in an associated encasing unit which accommodates only the associated support chain(s), such that this is replaceable separately from lines routed in the encasement.

7,690,718	B2	4/2010	Blase	
7,784,259	B2	8/2010	O'Rourke et al.	
8,561,949	B2	10/2013	Komiya et al.	
8,662,456	B2	3/2014	Komiya	
9,029,698	B2	5/2015	Komiya	
10,591,089	B2	3/2020	Barten et al.	
2022/0268337	A1*	8/2022	Hermey .....	F16G 13/16
2022/0268372	A1*	8/2022	Roessel .....	F16L 3/13

**19 Claims, 9 Drawing Sheets**

- (51) **Int. Cl.**  
*H01R 13/52* (2006.01)  
*H01R 13/627* (2006.01)  
*H01R 13/639* (2006.01)  
*F16G 13/16* (2006.01)  
*F16L 3/26* (2006.01)  
*H02G 3/04* (2006.01)  
*H02G 11/00* (2006.01)
- (52) **U.S. Cl.**  
 CPC ..... *H01R 13/52* (2013.01); *H01R 13/6271* (2013.01); *H01R 13/639* (2013.01); *H02G 3/0462* (2013.01); *H02G 11/006* (2013.01)

**References Cited**

U.S. PATENT DOCUMENTS

6,745,555	B2	6/2004	Hermey et al.
7,437,052	B2	10/2008	Klein

FOREIGN PATENT DOCUMENTS

DE	907548	3/1954
DE	8801061	6/1989
DE	102006019133	6/2007
DE	102012100533	8/2012
DE	102014104879	10/2014
DE	112017000173	1/2019
EP	1220398	7/2002
EP	1793151	4/2005
WO	02086349	10/2002
WO	2016042134	3/2016

OTHER PUBLICATIONS

Office Action from related Indian Appln. No. 202137034857, dated Feb. 16, 2023. English translation included.  
 Office Action from related Singaporean Appln. No. 11202107736V, dated Mar. 29, 2023.  
 International Search Report from corresponding PCT Appln. No. PCT/EP2020/050842, dated Feb. 26, 2020.  
 International Preliminary Report on Patentability from corresponding PCT Appln. No. PCT/EP2020/050842, dated Mar. 18, 2021.

\* cited by examiner

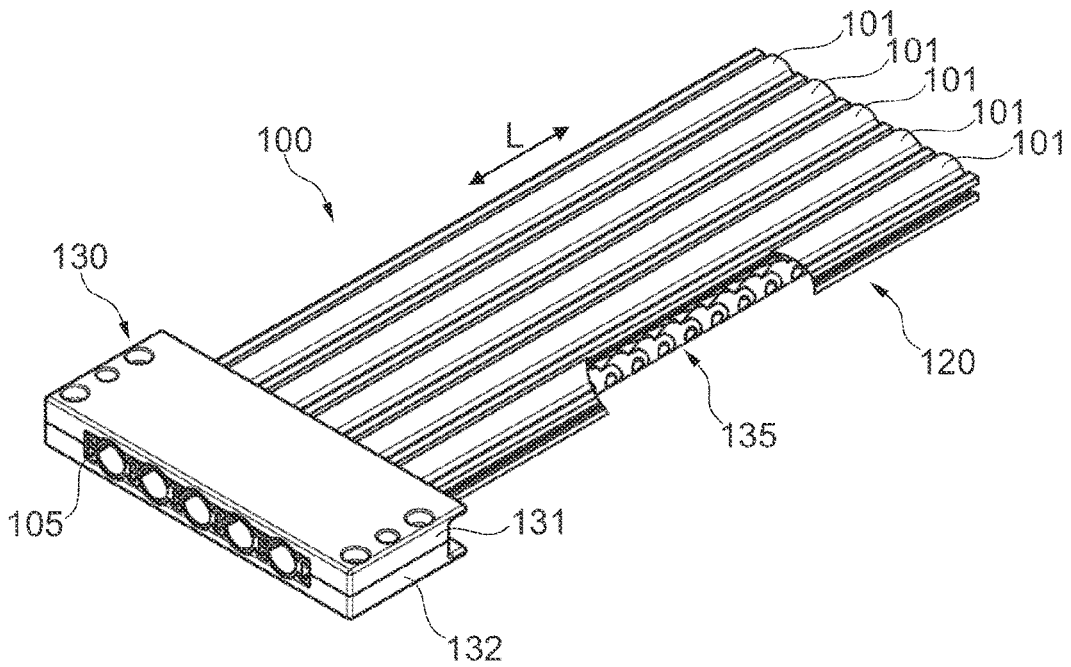


Fig.1A

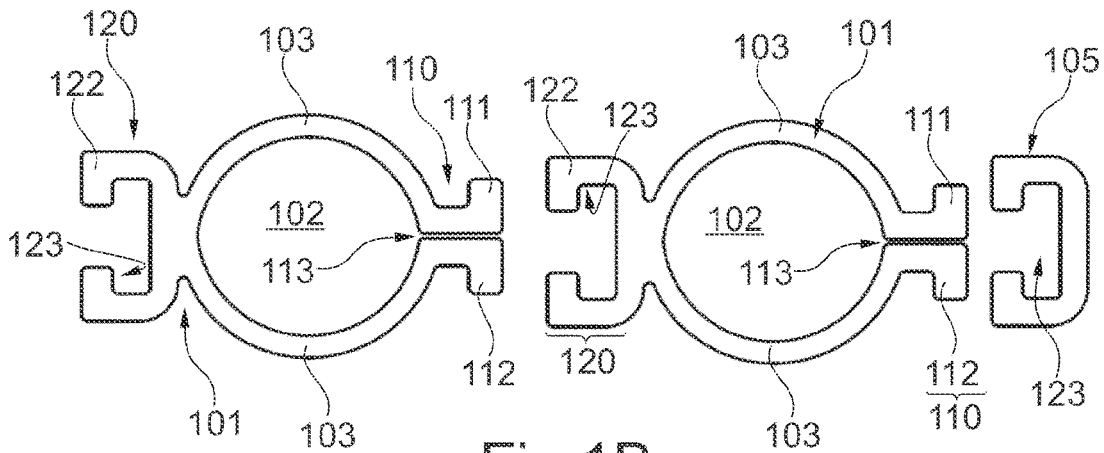


Fig.1B

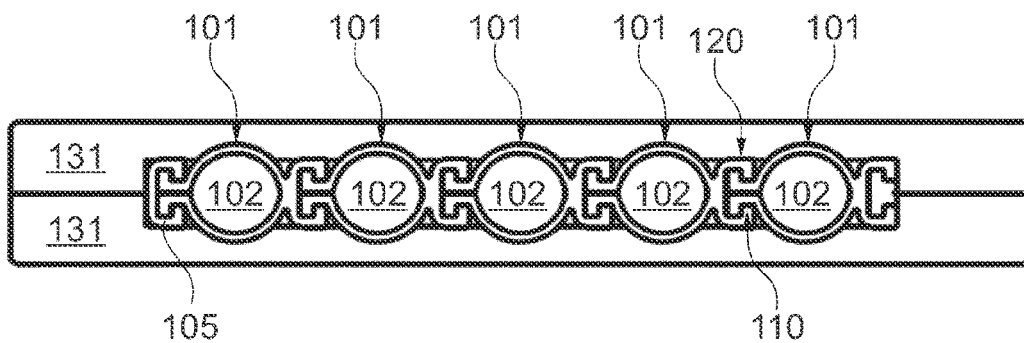


Fig.1C

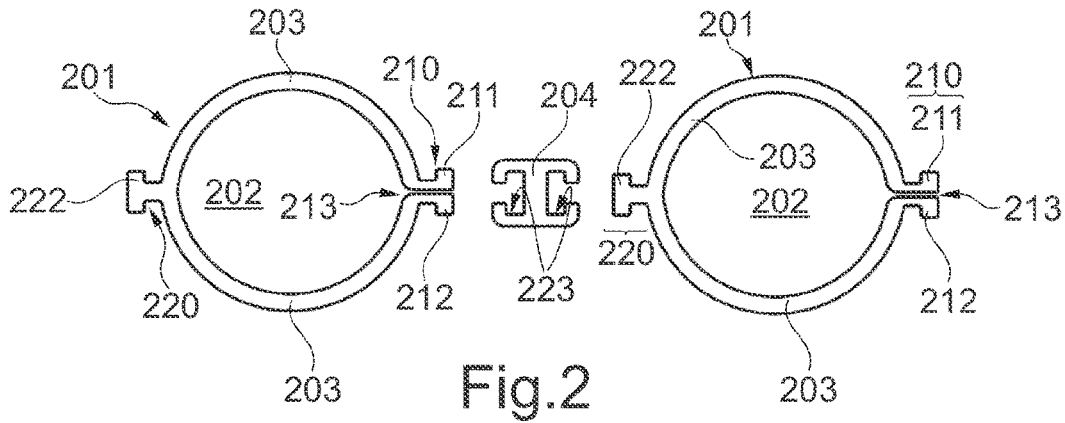


Fig. 2

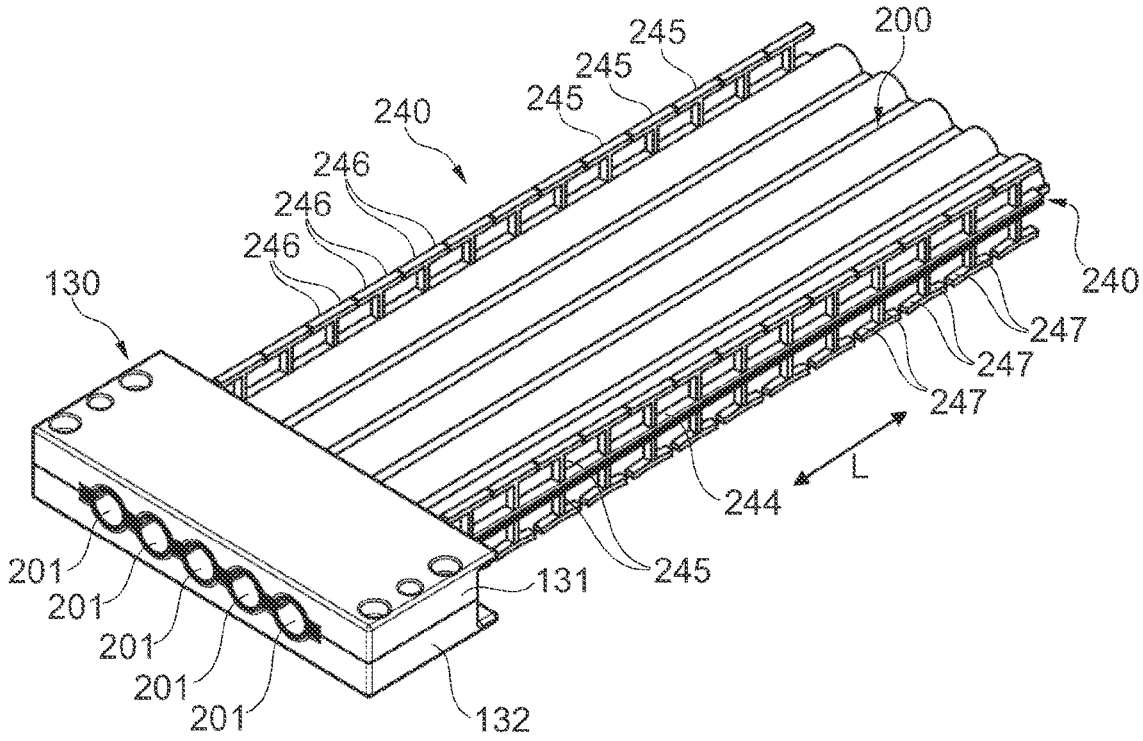


Fig. 3A

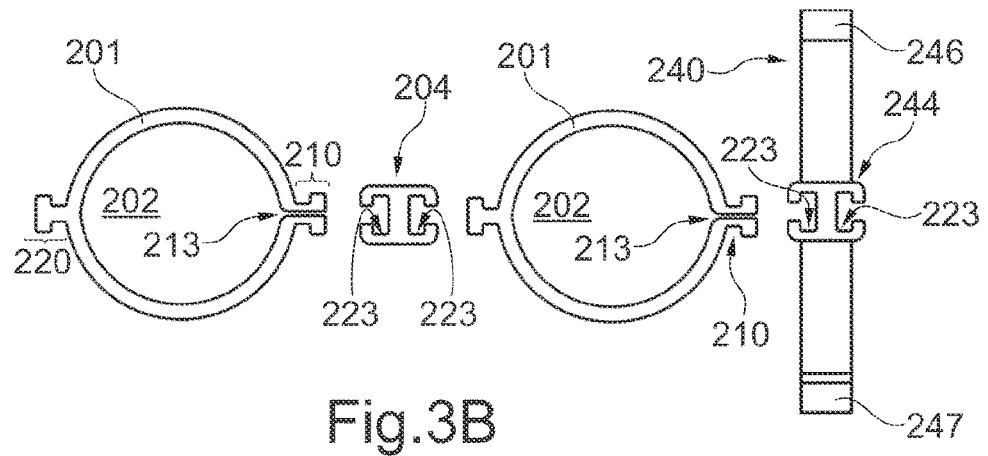
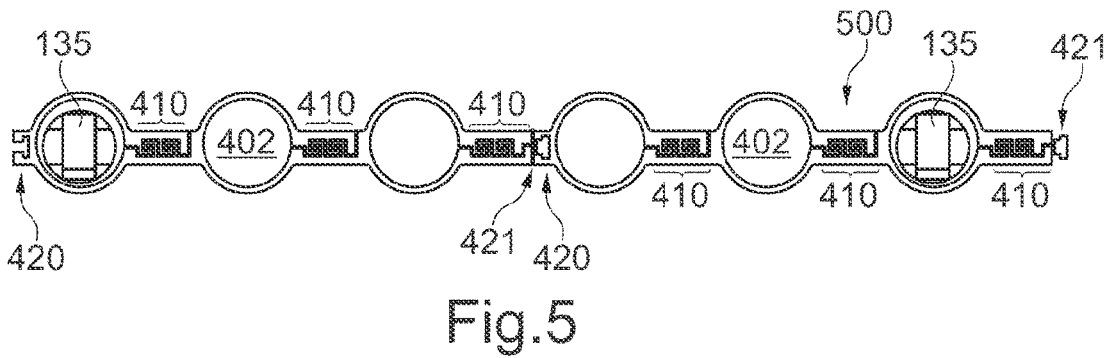
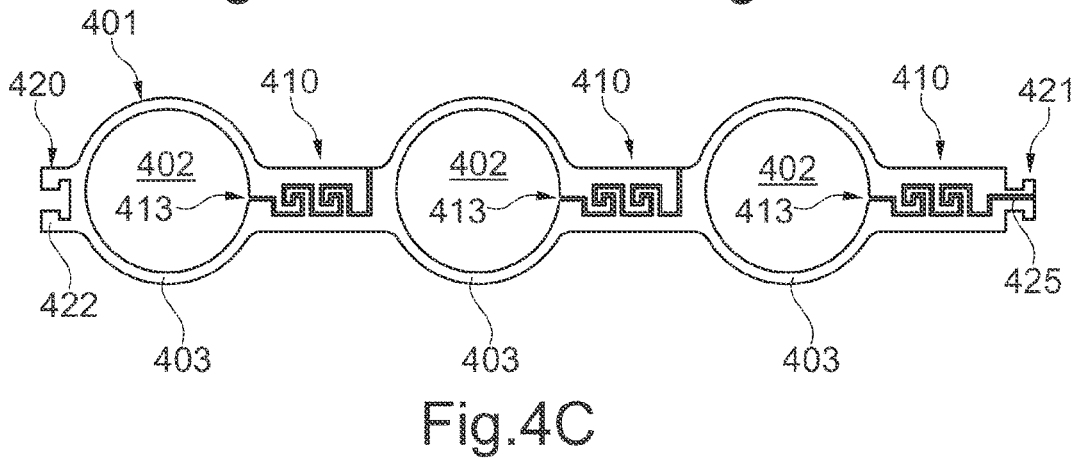
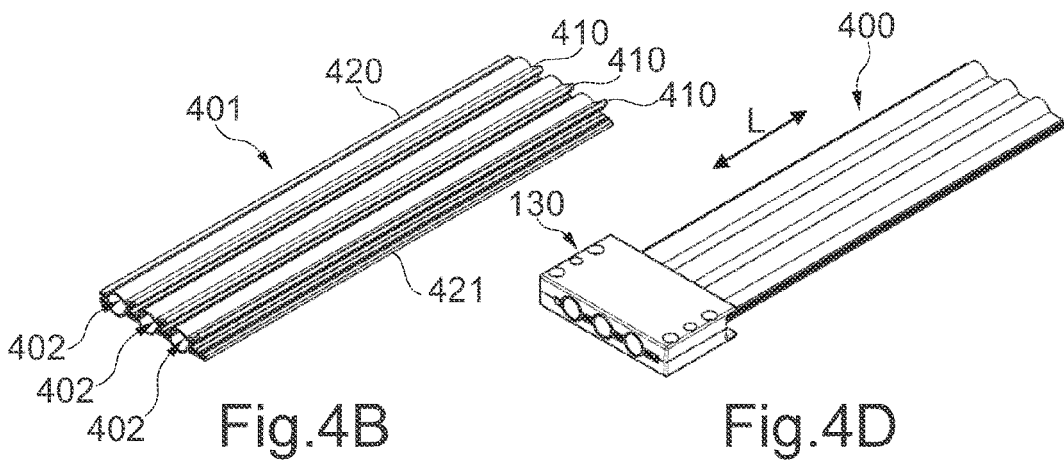
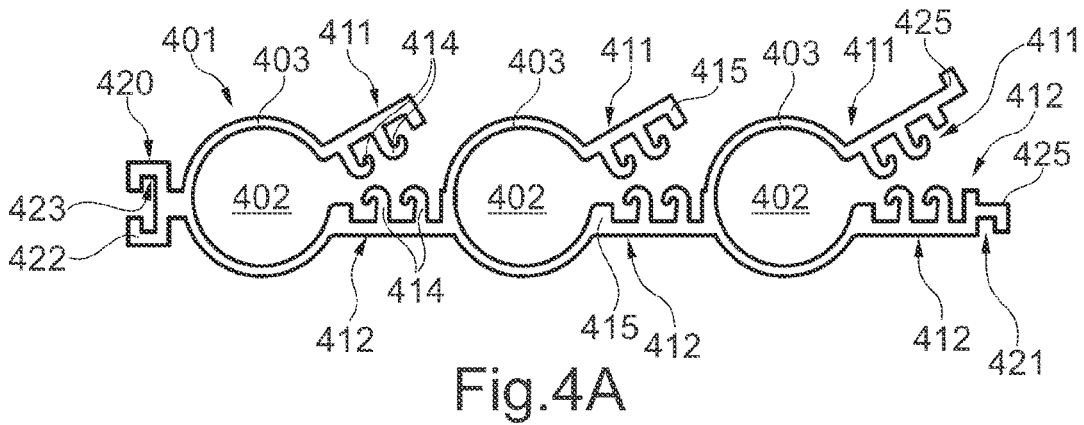
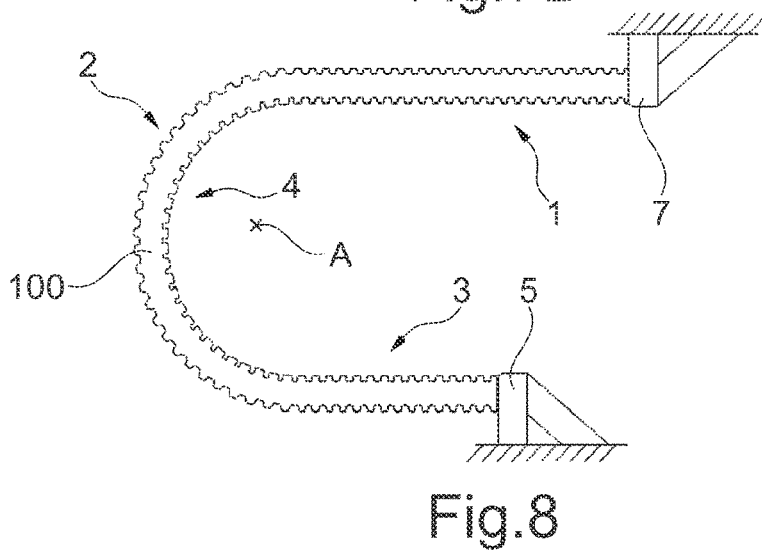
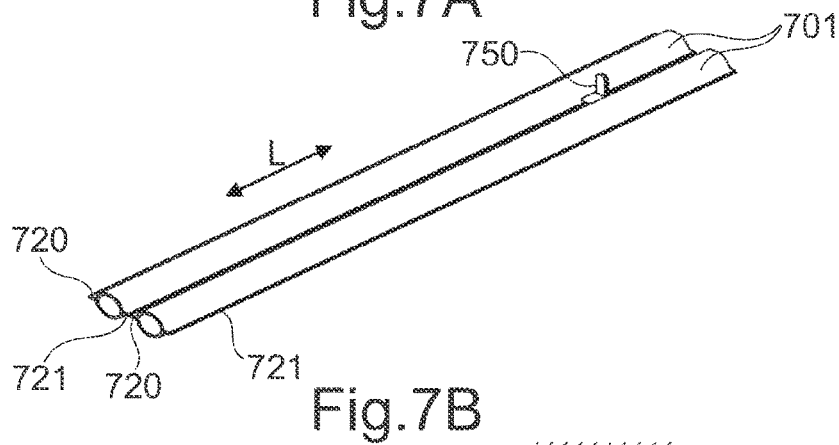
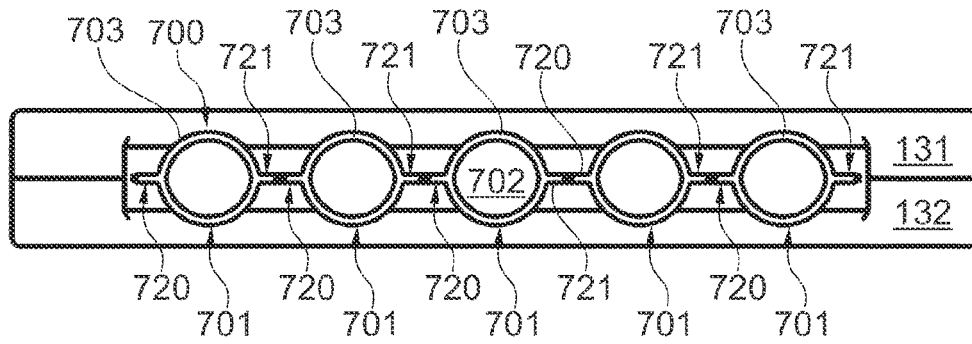
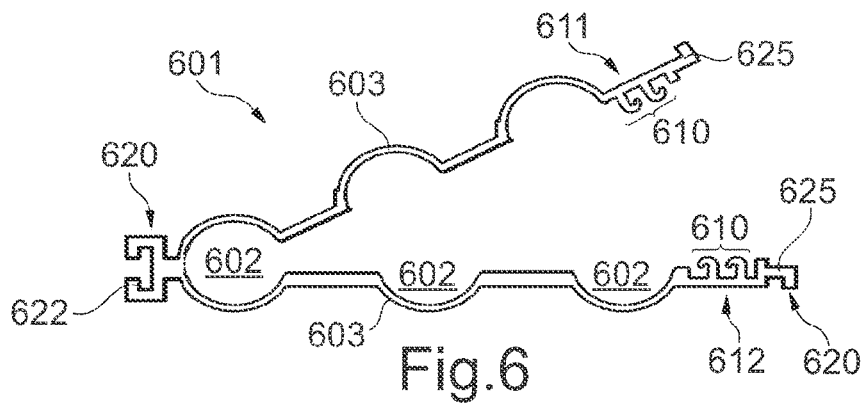


Fig. 3B





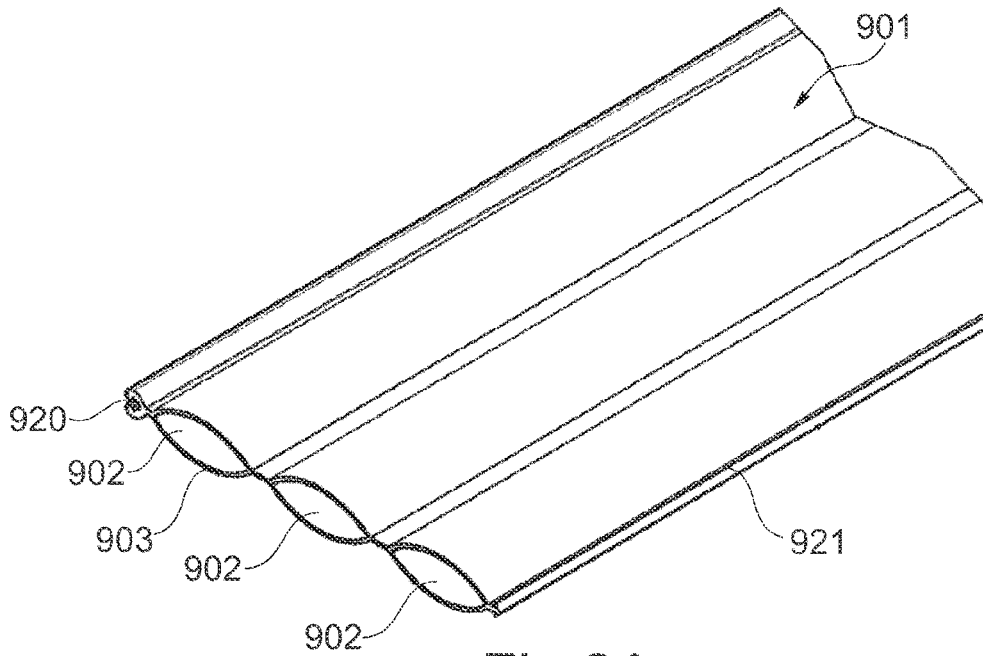


Fig.9A

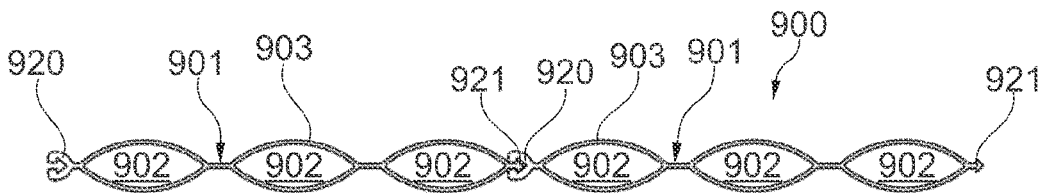


Fig.9B

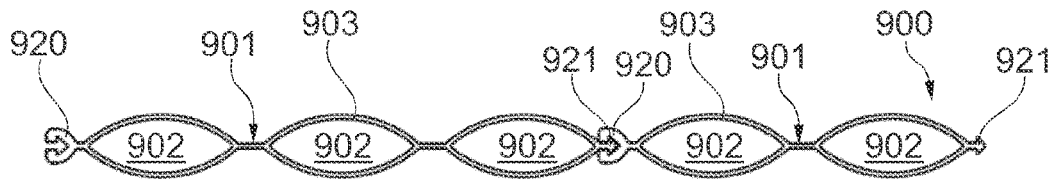


Fig.9C

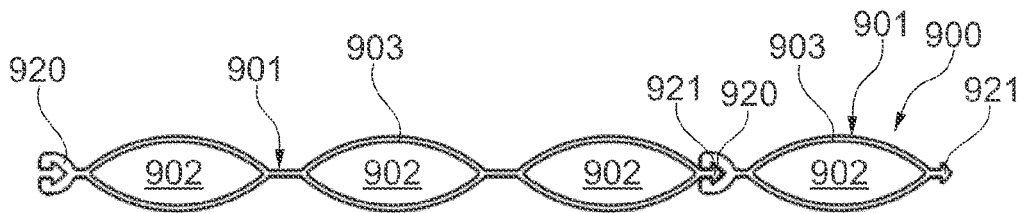
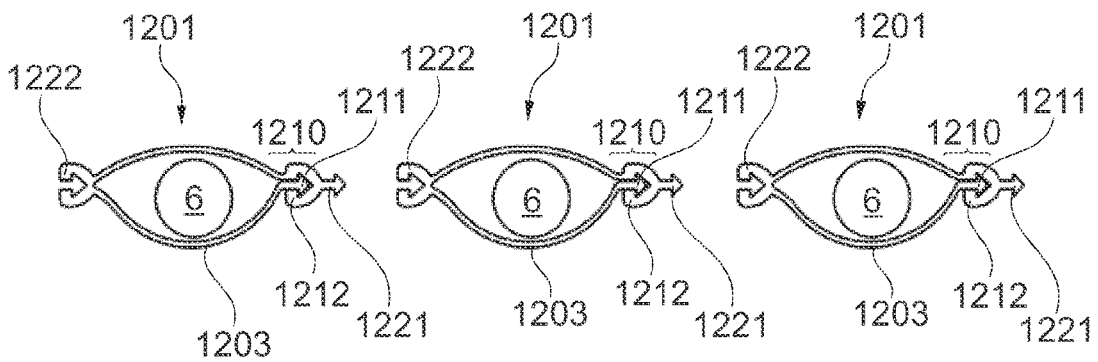
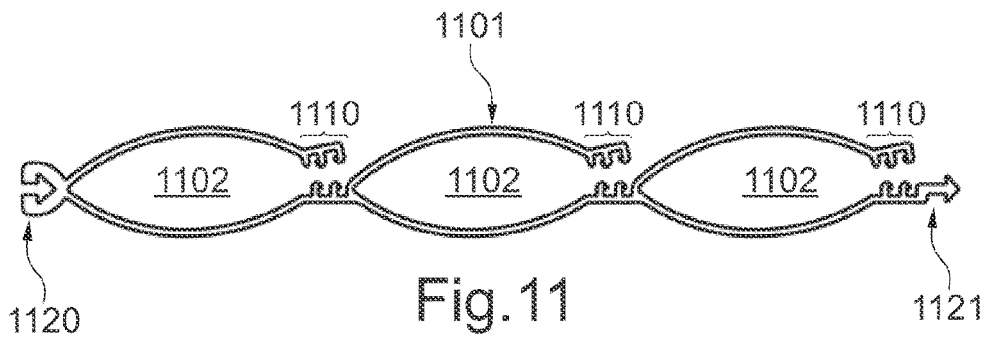
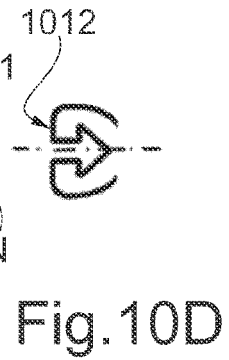
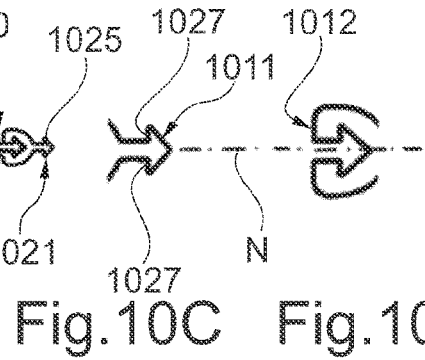
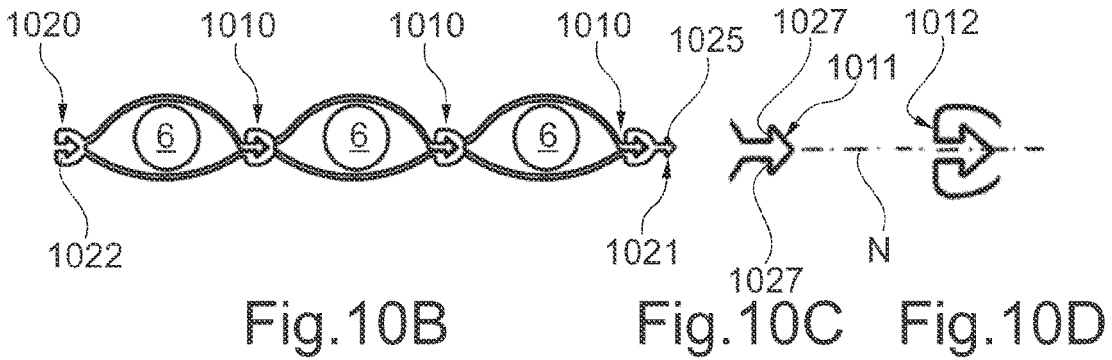
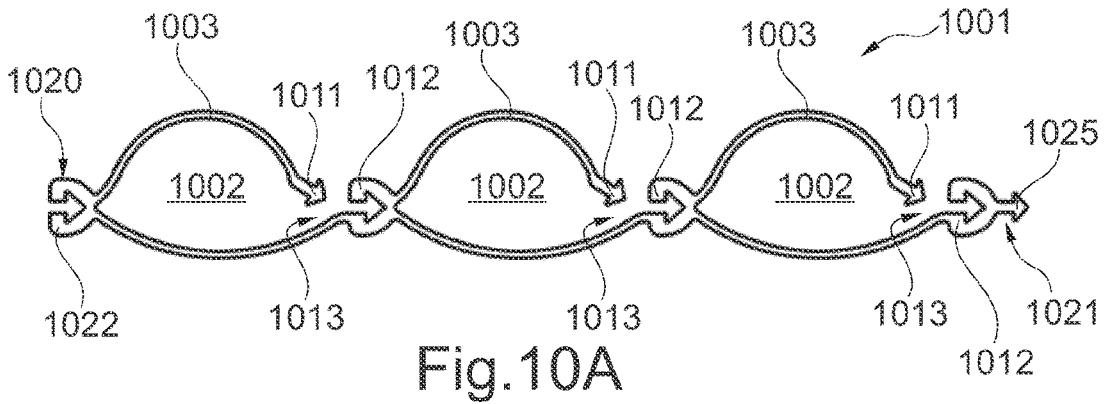


Fig.9D





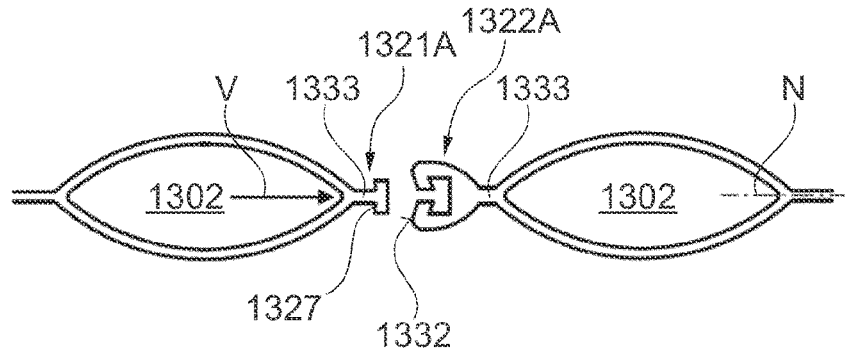


Fig. 13A

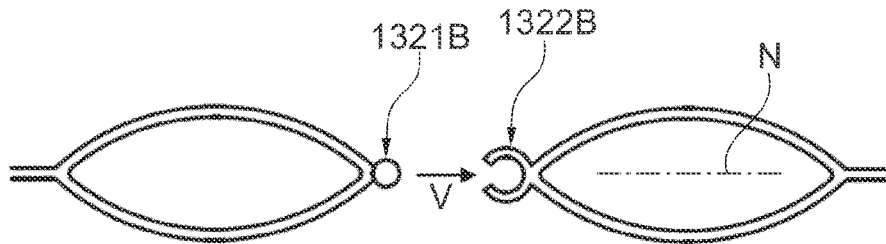


Fig. 13B

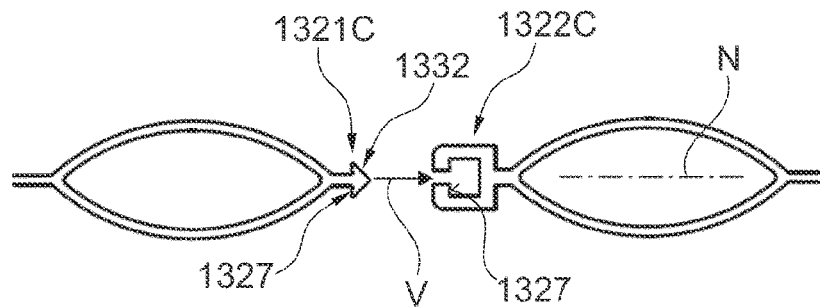
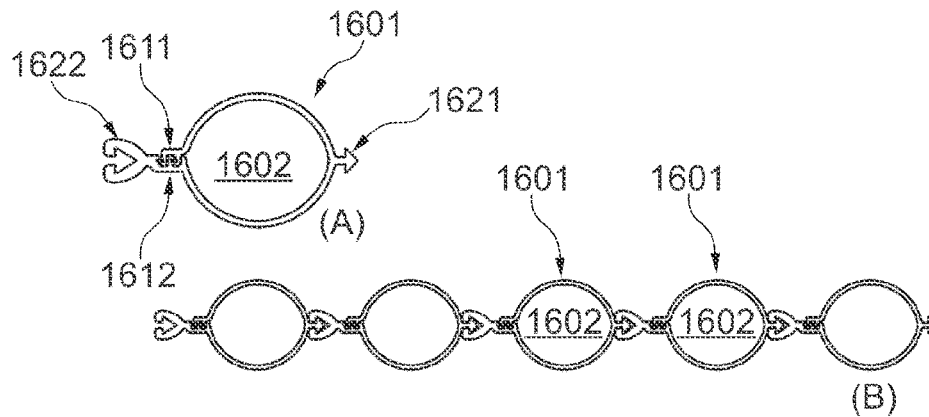
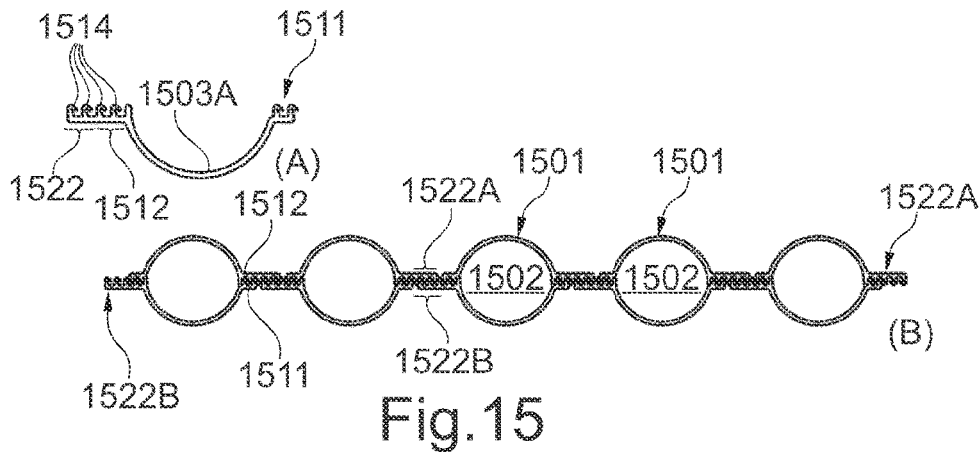
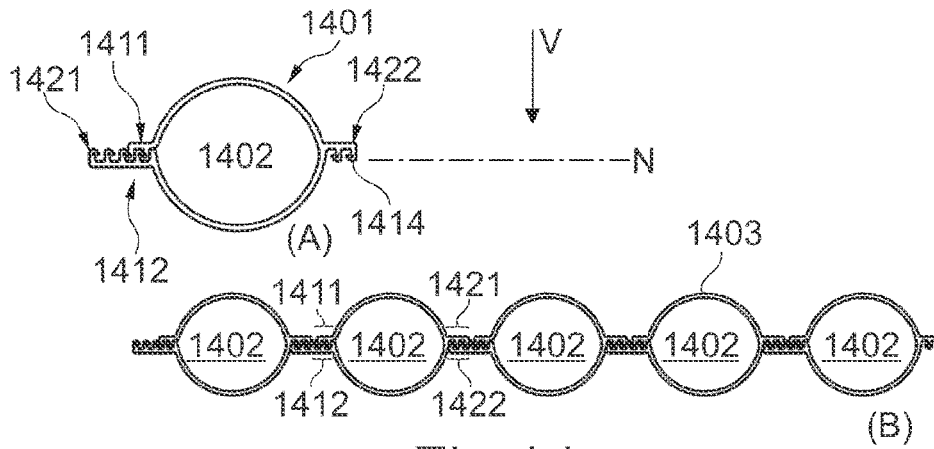


Fig. 13C



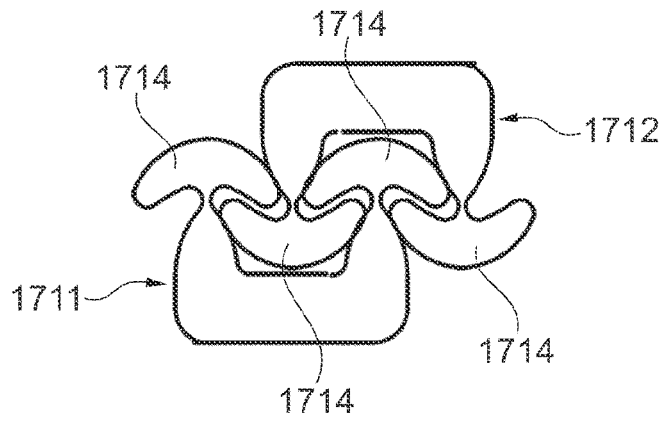


Fig. 17

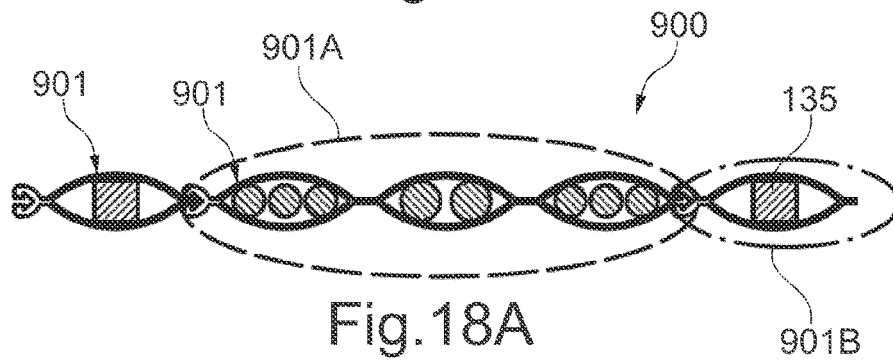


Fig. 18A

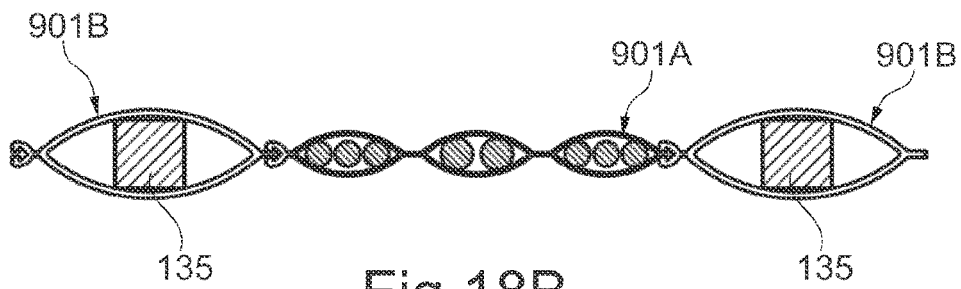


Fig. 18B

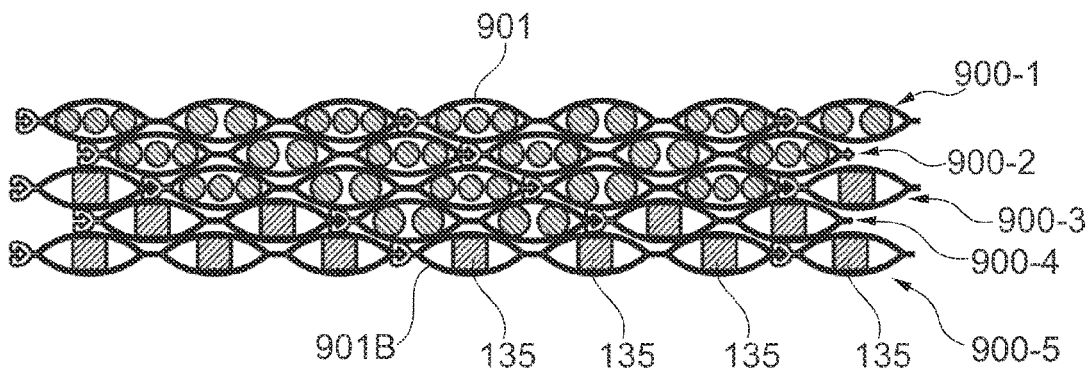


Fig. 19

**COMPACT PROTECTIVE CABLE CONDUIT  
FOR CLEAN ROOM APPLICATIONS AND  
ENCASING UNIT AND ARRANGEMENT  
WITH SUPPORT CHAIN FOR SAME**

FIELD

The invention generally concerns the field of line guide devices for lines like for example cables for signal or power supply or pneumatic or hydraulic hoses or the like, which are to be dynamically guided between two relatively moveable connecting locations of a machine or installation. In particular a dynamic line guide device is proposed, which is suitable for use in clean rooms, for example in semiconductor or flat-screen display manufacture, in pharmaceutical installations, in medical equipment and so forth. In such applications the release of particles by the line guide devices is particularly undesirable and has to be minimised to the greatest possible extent.

BACKGROUND

Energy guide chains are typical line guide devices but in the conventional link chain structure with rotary joints they are less suitable for clean room applications as such link chains themselves release particles in operation thereof due to abrasive wear. An energy guide chain which was further developed in that respect and which is suitable for a clean room situation was proposed in WO 02/086349 A1. That energy guide chain gives off markedly less abrasion by virtue of flexible joint connections.

A known problem however is that the lines guided in an energy guide chain which possibly suffers from low abrasive wear themselves release particles in operation thereof as they move, bend and rub against each other upon being displaced. Thus for example the sheaths of the cables themselves also give off particles to the surroundings upon displacement.

For that reason it is known for the lines to be dust-tightly encased. A number of line guide devices which were further developed for that purpose for clean room applications were proposed by the applicant in WO 2016/042134 A1. One of those solutions (see FIGS. 10 to 16 therein) has in the meantime become available under the trade name "e-skin" from the applicant (igus GmbH, D-51147 Cologne).

The present invention now specifically concerns a line guide device or line protection guide suitable for a clean room application, having an elongate flexible encasement which is reversibly or reciprocatingly displaceable, typically with the formation of a direction-changing arc between two runs between a first connecting location and a connecting location which is moveable relative thereto. In that case the proposed encasement has a number of receiving means of pronounced tubular configuration for guiding at least one line, wherein each receiving means extends channel-like in a longitudinal direction from a first end to a second end, with which the protective guide is mounted at the connecting locations.

Line protective guides of the general kind set forth of that type are available for example under the trade name "GORE® Trackless High Flex" from W. L. Gore & Associates, Inc or under the trade name "ChannelFLEX™" or "EcoFlex™" from Hitachi Cable America Inc. A variant of the last-mentioned line protective guide is described for example in DE 10 2012 100 290 B4 and U.S. Pat. No. 8,662,456 B2.

Such line protective guides are technically of a simple structure and are of a light and compact construction. They have a considerable disadvantage in use for example in relation to WO 2016/042134 A1. A maintenance operation, in particular replacement of an individual line or an individual line strand within a line guide arrangement including a plurality of lines or a plurality of line strands is possible only with considerable effort. In particular replacement of individual lines or individual line strands by lines which were already suitably prefabricated with the desired plugs or couplings is in particular not possible on site. That would considerably simplify maintenance and reduce costs. In contrast thereto line guides of the general kind set forth are typically completely renewed as an assembly so that in that case intact lines also have to be replaced. In addition a subsequent modification to an installed line guide, for example for adding further lines, is not readily possible.

DE 88 01 061 U1 discloses a line assembly with two support chains arranged at both sides, which is held together by means of multi-part clamping bars. The support chains are respectively accommodated in a separate tube. To replace one of those tubes the associated clamping bar has to be unscrewed.

In another part of the field involving line guides, more specifically line guides which are moveable in a multi-axial configuration for robot arms EP 1 793 151 A1 discloses a line assembly having flexible energy-carrying lines connecting a connecting location which is stationary or fixed with respect to a machine to a moveable part of the machine. In that case each line is fixedly enclosed in or by a flexible hose, wherein a T-shaped groove or a T-shaped projection is formed on the hose, extending over the length of the line. In that arrangement the T-shaped projection and the T-shaped groove of adjacent hoses engage into each other in positively locking relationship and are displaceable relative to each other in the longitudinal direction so that the hoses can be displaced axially relative to each other in the assembly. That solution is not designed to involve a low level of abrasive wear for clean room applications and allows replacement of individual lines only by complete withdrawal thereof in the longitudinal direction.

SUMMARY

With that background in mind a first object in accordance with a first main claim of the present invention is to propose a line protective guide which is of a relatively compact structure and/or which is low in weight and which at least partially overcomes the above-mentioned disadvantages.

The invention seeks in particular to simplify the replacement of individual lines or individual line strands and/or support chains which may optionally be employed. It also aims to simplify subsequent modifications.

Main Claim

In a line protective guide having an encasement which includes a first fixing strip at one longitudinal side and a second fixing strip at the second longitudinal side it is proposed according to the invention that the first and second fixing strips are arranged in opposite relationship and designed so that they can be connected together for a releasable connection by positively locking engagement and/or force-locking engagement in mutually matching relationship and in a connecting direction transversely to the longitudinal direction to fix a plurality of encasing units releasably to each other with mutually matching fixing strips

by connection of the fixing strips in the connecting direction transversely to the longitudinal direction. The first and second fixing strips are respectively in one piece with the encasing unit.

In that way individual encasing units can be selectively replaced completely with a fresh line strand and/or one or more support chains. In practice in particular separate replacement of support chains which are possibly in use has proven to be advantageous as they usually fail or have to be replaced before the supply lines. Thus a hitherto usual complete replacement of the entire line protective guide can be avoided.

The term line strand is used in that respect to denote a bundle of lines, in particular lines which are interrelated. In particular partial replacement of individual line strands is envisaged here, which are received by one or more encasing units with one or more receiving means.

In addition in accordance with a further aspect it can be provided that a functional region provides a closure for opening and closing one or more receiving means so that one or more lines can be inserted or removed transversely to the longitudinal direction or laterally/radially, in particular without dismantling of the complete encasement. For that purpose the functional region can have in particular two cooperating closure profiles which are designed for closure in as dust-sealing relationship as possible and which permit an opened state of the receiving means, in which a line can be inserted or removed transversely to the longitudinal direction.

According to the basic concept of the present invention it is provided that the or a functional region includes or forms a fixing strip for releasing or fitting at least a part of the encasement or a receiving means, as required.

The fixing strip can basically be designed in accordance with any connecting principle, involving positively locking and/or force-locking engagement, for non-destructive releasable connection to a corresponding strip or cooperating functional region. The fixing strip can be designed in particular in the form of a fixing bar or fixing profile.

In that respect the design configuration of the fixing strips is so selected that they are adapted to be connected to each other in a connecting direction transversely to the longitudinal direction, in particular perpendicularly to the longitudinal direction. In that respect the expression transversely to the longitudinal direction signifies in particular a connecting or joining direction in a plane perpendicular to the longitudinal direction of the individual channel-like receiving means so that an encasement serving as a replacement with fresh contents, for example fresh lines or in particular one or more fresh support chains can be easily fitted laterally to the rest of the arrangement which is already fitted in place without the remaining encasements having to be released or indeed dismantled from each other. In general for that purpose only the end connection, for example clamping devices there, are to be opened for the replacement operation.

In accordance with a basic concept if required only a part of the encasement together with the lines in question or in particular one or more support chains to be replaced is changed. In that respect consideration is to be given both to replacement of an individual receiving means with one or more lines or support chains or replacement of an encasing unit with a line strand.

In an embodiment the encasement includes a multiplicity of separate encasing units and each encasing unit has two fixing strips which are in opposite relationship on both sides and which are in one piece with the encasing unit. Adjacent

encasing units are connected together in parallel relationship by the fixing strips and provided at the first and second end is a respective clamping device, with which the multiplicity of separate encasing units of the encasement are respectively secured at the end.

An encasing unit respectively has at least one receiving means for one or more lines or a line strand or also for a support chain of per se known structure. The receiving means can be in particular of a tubular configuration.

Particularly in the case of applications involving longer travel distances or encasements it is advantageous if provided in a receiving means of at least one encasing unit is a support chain for supporting the encasement upon displacement. In that respect it is possible to use per se known support chains involving the structural configuration of link chains.

In an embodiment the encasement includes at least one encasing unit of soft-elastic or flexurally elastic plastic which is preferably in one piece. The encasing unit could also be of a multi-part composition, for example comprising two symmetrical half cases or tube portions which are similarly divided in the longitudinal section. A one-piece encasing unit is preferred here and can improve for example sealing integrity to prevent particle escape.

Wall thickness and material of the encasement are so selected that it is flexible. A plastic, in particular a thermoplastic, with a Shore hardness in the range of 20 Shore A (ShA 20) to 65 Shore D (ShD 65), in particular in the range of 50 Shore A (ShA 50) to 100 Shore A (ShA 100) is considered as the soft-elastic or flexurally elastic plastic.

In a preferred configuration the fixing strip is respectively connected in one piece to the encasing unit (so-to-speak releasable only by destruction thereof). For that purpose it can be produced directly in one piece with the encasing unit or also it can be produced separately and subsequently joined thereto in material-bonded relationship by a joining process, for example by a suitable thermal joining process, in particular welding. The context of the invention includes in particular separate manufacture of a "simplified profile" without functional region on the one hand and the functional region or fixing strip on the other hand, for example in each case by extrusion of various, particularly suitable plastics, in particular thermoplastics. The functional region or the fixing strip can then be joined in material-bonded relationship in the longitudinal direction to the rest of the encasing unit to constitute one part, for example by a welding process for welding plastics.

In an embodiment the encasement is composed of a multiplicity of separate encasing units. In that case each encasing unit can respectively form precisely one receiving means and can respectively have a lateral fixing strip in one piece with the encasing unit, for example a bar or a profile.

In addition an encasing unit can also include a multiplicity of receiving means and can respectively have a lateral fixing strip in one piece with the encasing unit. In that way individual encasing units can be connected together in parallel to form an encasement. In a development in that respect each encasing unit can have two fixing strips which are in opposite relationship at both sides and which are in one piece with the encasing units and by means of which adjacent encasing units can be connected to each other in parallel relationship. The fixing strips can be designed for direct cooperation in mutually matching relationship, for example of a conjugate configuration or engaging into each other in form-locking relationship. They can also cooperate with a separate fixing bar which is used for fixing the encasing units together.

5

In a preferred configuration an encasement is formed by a multiplicity of encasing units which respectively have the same number or a differing number of receiving means. Optionally an individual encasing unit can in particular have so many receiving means that a line strand can be received by precisely one encasing unit. This advantageously makes it possible for individual line strands within an encasement to be replaced by replacement of the respectively associated encasing unit. In that respect the term line strand is used to denote in particular bundles or groups of functionally inter-related lines, for example grouped in accordance with susceptibility to wear or service life.

To reduce deformation in the direction-changing arc each receiving means has a long round or oval, in particular ogival, cross-section, with the fixing strips being arranged at the narrow sides.

Each encasing unit can also have laterally, in particular in opposite relationship to the fixing strip, two closure profiles which are in one piece with the encasing unit.

In an embodiment it can be provided that the closure profiles of an encasing unit are closable in positively locking and/or force-locking relationship by connection to the fixing strip of an adjacent encasing unit. In that way for example in the event of oversize of the closure profiles which engage into the oppositely disposed fixing strip it is possible to achieve a particularly robust closure without additional fitment steps. Alternatively adjacent encasing units can be respectively connected together in parallel by a separate flexible fixing bar which cooperates with the fixing strips. In that way release of the closure is separate from the fixing by the fixing strips, that is to say separation of an encasing unit cannot result in unwanted opening of the adjoining encasing unit so that no abrasive wear particles are unintentionally discharged.

A further embodiment provides that the encasing unit includes subdivisions which form a plurality of parallel receiving means and the encasing unit has a closure, in particular two closure profiles in one piece with the encasing unit. In that way inter alia the assembly effort in relation to applications with a large number of lines to be guided can be reduced as an individual encasing unit to be fitted is not provided for each line. In this embodiment each receiving means preferably has an associated dedicated closure so that all lines remain separately accessible. For that purpose each receiving means can have a pair of cooperating closure profiles in one piece with the encasing unit.

When long guide lengths or particularly soft-elastic encasements or encasing units are involved it is possible to provide in at least one and preferably in two laterally outer receiving means a support chain, in particular comprising individual chain links, which is designed to predetermine a direction-changing radius for the direction-changing arc and/or to support a self-supporting run in the straight position.

In a preferred embodiment a fixing profile as the fixing strip is provided at each narrow side of the encasement, in the case of a subdivided encasing unit, in particular in each case in one piece therewith. Besides expandability in that way for example as a alternative to a support chain another kind of support device can be mounted externally to the fixing profiles of the encasement. This provides that no useable receiving passage is required for the support function. For that purpose a respective external support device can be connected to the fixing profile at each narrow side of the encasement, which support device is designed to involve a low level of abrasive wear in order to predetermine a radius of the direction-changing arc and/or to support a self-

6

supporting run in the straight position. Preferably for that purpose each support device has a support band and abutment elements perpendicular thereto, in particular T-shaped abutment elements, the T-arms of which are in an abutment condition in the direction-changing arc radially inwardly or in the straight position. The carrier band is preferably at the height of the neutral fibre.

An embodiment provides that the encasement includes a multiplicity of separate and peripherally closed encasing units. In that arrangement each encasing unit can respectively form precisely one receiving means. Each encasing unit can have two fixing strips which are in opposite relationship at both sides and which are in one piece with the encasing units as functional regions for fixing purposes. In that case the fixing strips can be adapted for positively locking cooperation directly with each other, for example in the manner of a zip fastener or a sliding closure or the like, or can cooperate with a separate fixing bar in positively locking and/or force-locking relationship.

In accordance with each of the two aspects, also with a combination of the closure and fixing functions, encasing units can be of a cross-section which remains the same in the longitudinal direction. That allows profile-like manufacture in an extrusion process, preferably using soft-elastic or flexurally elastic plastic. The functional region can possibly be separately extruded in that case.

Accordingly in particular also the first and the second fixing strip can be of a cross-section which remains the same in the longitudinal direction, for example with interengaging hook and claw profile or similar suitable configuration, preferably with a barb function.

A functional region serving as a closure can also be manufactured for example by extrusion, if the functional region has two conjugate interengaging closure profiles of plastic which remain the same throughout in the longitudinal direction and which cooperate as a press closure or toothless sliding closure or preferably similarly to a zip closure. In that case each closure profile can include two engagement profiles and so-to-speak form a double closure.

The arrangement may have two laterally mutually opposite fixing strips as functional regions, which each have a respective fixing profile, wherein the fixing profiles are preferably designed for a positively locking connection, for example a tongue-and-groove connection or the like, which is releasable only in the longitudinal direction. Unintentional release of encasing units can be avoided in operation in that way.

For the same purpose the fixing strips or fixing profiles are preferably so designed that in comparison to the connection of mutually matching fixing profiles in the connecting direction, they are releasable only with a markedly greater force in opposition to the connecting direction or are releasable only in the longitudinal direction. For that purpose the fixing profiles can preferably be of a cross-section with a barb function, but other shapes are also possible.

To facilitate the connection of two encasements in the desired connecting direction it is advantageous if the first fixing profile and/or the second fixing profile has at least one inclined insertion portion extending inclinedly relative to the connecting direction. A corresponding geometrical shape is described for example in EP 1 220 398 A2, there for fixing profiles for bundling static cables or hoses. In a preferred development the fixing profile is of a symmetrical configuration relative to a central plane, in particular the neutral fibre, wherein the first fixing profile and/or the second fixing profile can have two symmetrically arranged inclined insertion portions.

Preferably adjacent receiving means are connected or coupled together in parallel by intermediate regions in band form, which predetermine the neutral fibre. Alternatively or in addition preferably in relation to each closure comprising cooperating closure profiles the interface is at the level of the neutral fibre of the encasement. The neutral fibre is to extend in particular centrally through the cross-section of the receiving means. In that respect a band-shaped intermediate region which is thinner in comparison with the structural height of the respective fixing strip can be provided between each fixing strip and an adjoining receiving means. In that way it is possible in particular to achieve good flexibility of the direction-changing arc about the desired axis with sufficient stiffness in the transverse direction. Preferably the encasement is designed to be displaceable substantially linearly (not multi-axially).

Clamping devices can be provided on the encasement at the end, which close the encasement and optionally the lines in the axial direction to prevent the discharge of dust particles. In the typical situation of use at least two lines and in most cases a multiplicity of lines are guided separately from each other in a respective receiving means and are enclosed to be as dust-tight as possible by the encasement. No particles are to issue even at the ends.

The invention also concerns an encasing unit as an individual part for the production of an encasement according to one of the preceding embodiments. That encasing unit is produced for example from plastic, in particular soft-elastic or flexurally elastic plastic, and has at least one tubular receiving means for guiding at least one line, which extends channel-like in a longitudinal direction from a first end to a second end. In that case the encasing unit can be considered as a sheath for encasement dust-tightly in the peripheral direction of the line or lines and typically loosely surrounds the lines (in contrast to an actual insulating cable sheath).

The encasement has a first fixing profile at one longitudinal side and a second fixing profile at the other longitudinal side. The encasing unit can form a plurality of pronounced receiving means which in particular are parallel and tubular for separate guidance of at least one respective line or in each case precisely one receiving means.

According to the invention the encasing unit has a first fixing profile at one longitudinal side and a second fixing profile at the other longitudinal side, and the fixing profiles are arranged in opposite relationship and designed for releasable connection by positively locking connection and/or force-locking connection in mutually matching relationship. That allows a plurality of encasing units with mutually matching fixing profiles or fixing profiles which are of the same structural configuration in pairs to be releasably fixed together. In that case the fixing profiles can be of such a design configuration that they can be connected together in a connecting direction transversely relative to the longitudinal direction.

In regard to fixing profiles of the same structure consideration is to be given in particular to a bar or a profile, wherein the encasing unit can have a bar at a first longitudinal side and a profile at a second longitudinal side and wherein the bar of a first encasing unit can be connected to the profile of a second encasing unit in positively locking relationship and/or by force-locking relationship. In that case the first encasing unit can be in particular of the same structure as the second encasing unit or for example can have a different number of receiving means.

According to the invention, the encasing unit has a first fixing profile at one longitudinal side and a second fixing

profile at the other longitudinal side, which are of a complementary or conjugate configuration or which match each other but are different from each other, wherein the fixing profiles are adapted for a releasable connection by positively locking engagement and/or force-locking engagement in mutually matching relationship in order to fix a plurality of structurally identical encasing units releasably to each other. The first and second fixing profiles are respectively in one piece with the encasing unit.

The proposed encasing unit itself can advantageously have one or more of the features constituting a development thereof. In addition the encasing unit can form a plurality of or precisely one tubular receiving means for separate guidance of at least one respective line or line strand. This embodiment is advantageous if the encasing unit is produced closed in the peripheral direction around the receiving means so that discharge of particles at the location of operation is reliably prevented.

#### Further Independent Claim

In addition, independently of the foregoing an arrangement having one or more support chains is proposed. In such an arrangement of the general kind set forth it is proposed according to the invention that each support chain is guided in an associated encasing unit which serves exclusively for the support function or which accommodates the associated support chain or chains so that with the associated encasing unit the support chain or chains are or can be replaced separately from the lines guided in the encasement. In that way—in contrast to the hitherto usual practice—in the event of a threat of failure or actual failure of a support chain there is no longer any need to replace the entire line guide together with lines which are typically still operable. The replacing encasing unit with support chain or chains can then be attached for example in a simple step laterally to the existing structure and fixed by means of the fixing strips or profiles. The first and second fixing profiles are respectively in one piece with the encasing unit. The encasing units can be designed in particular according to one of the above-described preferred embodiments.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Further details and features of the invention will be apparent without limitation on the generality of the foregoing from the description hereinafter of preferred embodiments by way of example with reference to the accompanying drawings in which:

FIGS. 1A-1C show a first embodiment by way of example of a displaceable line protective guide having a flexible encasement, as a partial view of an end region, partly broken-away (FIG. 1A), as a cross-section through individual encasing units (FIG. 1B) and as a front view of an end having an end clamping device (FIG. 1C),

FIG. 2 shows a further embodiment with individual encasing units which are modified in relation to FIGS. 1A-1C as a cross-sectional view (exploded),

FIGS. 3A-3B show a development with encasing units as shown in FIG. 2 and additional support devices exploded as a cross-sectional view (FIG. 3B) and a perspective partial view of an end region (FIG. 3A),

FIGS. 4A-4D show a further embodiment with a one-piece encasing unit subdivided to form a plurality of line receiving means, in the opened state in cross-section (FIG. 4A) and as a perspective view (FIG. 4B) and closed as a

cross-section (FIG. 4C) and as a perspective view with an end clamping device (FIG. 4D),

FIG. 5 shows an example of use with an embodiment as shown in FIGS. 4A-4D with two subdivided encasing units which are coupled together in parallel and outward support chains as a cross-section,

FIG. 6 shows a cross-section of a further embodiment with a closure which is modified in relation to FIGS. 4-5,

FIGS. 7A-7B show a further embodiment with individual peripherally closed encasing units which are releasably connected together by lateral fixing profiles,

FIG. 8 shows a typical arrangement of a line protective guide or line protective device as a diagrammatic side view,

FIGS. 9A-9D show a particularly preferred embodiment with an encasing unit having a plurality of receiving means and connected together releasably by lateral fixing profiles,

FIGS. 10A-10D show a further embodiment with an encasing unit having a plurality of receiving means which can be individually filled and preferred cross-sections of associated functional regions,

FIGS. 11-12 show further embodiments as variants in relation to FIGS. 10A-10D,

FIGS. 13A-13C show further embodiments as variants in relation to the preferred embodiment of FIGS. 9A-9D,

FIGS. 14-16 show further embodiments of encasing units,

FIG. 17 shows a modification of a functional region as a closure or fixing, and

FIGS. 18A-18B show various arrangements with support chains; and

FIG. 19 shows a multilayer structure with a plurality of encasements.

#### DETAILED DESCRIPTION

FIGS. 1A-1C diagrammatically show a first embodiment by way of example of a reciprocatingly displaceable line protective guide for lines (not shown). It has an elongate flexible encasement 100 which is composed of a multiplicity of individual encasing units 101 produced from plastic. Each encasing unit 101 is made from a flexible soft-elastic plastic, in particular a thermoplastic, for example PE, PU, TPU, PTFE, expanded PTFE, PP or the like. Each encasing unit 101 over its length is of a cross-section which remains the same throughout (FIG. 1B) perpendicularly to the longitudinal direction L. The encasing unit 101 can be produced for example inexpensively as an extrusion in a suitable plastic extrusion process and can be cut to an appropriate length, for example from about 100 mm to about 1500 mm. The structurally identical encasing units 101 form in the interior thereof a substantially cylindrical receiving means 102 for protective guidance of a line and for that purpose are of a tubular configuration with wall regions 103 which are of thin gauge in relation to the cross-section of the receiving means 102. The receiving means 102 of the flexible encasement 100 are spatially separated from each other so that no abrasion can occur between lines guided in parallel therein.

Each encasing unit 101 at a longitudinal side has a first functional region 110 which in FIGS. 1A-1C comprises two closure profiles 111, 112 which are conjugate in mirror-image symmetry and which are in opposite separate relationship and which in a condition of jointly bearing against each other form a cross-section approximately of a T-shape. Each closure profile 111, 112 is continuous in the longitudinal direction L and here is approximately L-shaped for example in cross-section. As shown here the closure profiles 111, 112 can form L-limbs facing away from each other or L-limbs which are preferably disposed in each other or in

juxtaposed relationship in parallel to reduce the height of the closure. Between the closure profiles 111, 112, in particular centrally therebetween, the encasing unit 101 has an interface or an opening 113 which extends in the longitudinal direction L and radially. The opening 113 in gap form of a loose or separate encasing unit 101 (FIG. 1B) can be widened by bending open the encasing unit 101 in order to introduce a line prefabricated with plugs laterally or transversely relative to the longitudinal direction L into the receiving means 102 or to remove it therefrom.

The encasing unit 101, in diametrically opposite relationship to the first functional region 110, has a second functional region 120 comprising a fixing profile 122. The fixing profile 122 is continuous in the longitudinal direction L and for example is of a substantially C-shaped cross-section with an internal contour 123 which is sized in matching relationship with the external contour of the closed closure profiles 111, 112 of the first functional regions 110, in particular with a slight undersize for a positively locking and force-locking connection. By axially pushing the fixing profile 122 on to the closure profiles 111, 112 of an adjacent encasing unit 103 the opening 113 thereof can be closed so as to be at least substantially sealed in relation to particles and can be easily opened again to replace a line. The functional regions 110, 120, here together with the opening 113, by virtue of their longitudinal sectional plane of symmetry, define the neutral fibre of the flexible encasement 100, that is to say the longitudinal central plane, the length of which does not change upon bending or in the direction-changing arc 4 (FIG. 8), that is to say it has no tensile/thrust stress. In addition the additional wall thickness at the functional regions 110, 120 creates a comparatively stable encasement 100 which is displaced in a more controlled fashion without perceptibly adversely affecting the reversible flexibility thereof.

FIGS. 1A and 1C further show one of two end clamping devices 130 with two clamping parts 131, 132, between which all encasing units 101 of the encasement 100 together with lines (not shown) guided therein are dust-tightly closed off at the end and in the axial direction, for example by clamping screws. The clamping devices 130 can at the same time also provide for tensile stress relief of the lines (not shown) and can be of a per se known structural configuration, for example similarly to the teaching of DE 10 2012 100 290 B4 which is here incorporated in that respect.

FIG. 1A shows one of two support chains 135 which is accommodated in the receiving means 102 of the two laterally outer encasing units 101 and comprises individual chain links. Optional support chains 135 on the one hand can predetermine the minimum permissible radius at the direction-changing arc 4 (FIG. 8) to protect the chain from kinking and on the other hand by virtue of abutments for the chain links in the straight position can increase the self-supporting length of the encasement 100 in the moveable run, for example in the upper run 1 (FIG. 8).

As indicated in FIG. 1B the opposite closure profiles 111, 112 are connected in one piece to the wall regions 103 of the encasing unit 101, that are in the nature of a segment of a tube. The fixing profile 122 is also connected in one piece with the upper wall region 103 and the lower wall region 103. In particular the closure profiles 111, 112, as an alternative to an inexpensive production in one piece involving unitary material, can be produced separately from a suitable plastic and connected in material-bonded relationship to wall regions 103 or the encasing units 101 to form a composite material, preferably by plastic welding. The cross-section of the encasing units 101 or wall regions 103,



besides the illustrated approximately circular shape, can also be of an elongatedly round or oval shape. The illustrated cross-sectional shapes of the closure profiles **111**, **112** and the fixing profile **122** are shown here purely by way of example and can be of a different design, for example predominantly round. The number of parallel-coupled encasing units **101** as shown in FIGS. 1A-1C can be selected as desired to match the number of desired lines or can be subsequently enlarged by virtue of the functional regions **110**, **120**. The closure profiles **111**, **112** can additionally be designed at the inside for opening purposes (not shown here) in the form of a pressure closure, for example in accordance with the Ziploc® principle or the like in order to avoid unwanted widening of the opening **113** after separation of the adjacent encasing unit **101** (see also FIGS. 4A-4D).

FIGS. 1A-1C further show a closure bar **105** with an internal contour corresponding to the fixing profile **122**. The closure bar **105** serves (in relation to the discharge of abrasion particles) for sealingly closing the opening **113** or closure profiles **111**, **112** disposed at an outside with a laterally outer encasing unit **101**, similarly to the fixing profile **122**.

FIG. 1C illustrates the completely closed operating state of the encasement **100**, in which all fixing profiles **122** are connected in positively locking relationship and/or by force-locking engagement, for example a clamping action, to the opposite closed closure profiles **111**, **112** and close the interposed opening **113** dust-tightly and continuously in the longitudinal direction L.

Features involving a structure or function identical to or corresponding to FIG. 1 are denoted by corresponding references in FIGS. 2 to 7 and are possibly not described again.

FIG. 2 shows a preferred alternative encasing unit **201** having two functional regions **210**, **220** for the construction of an encasement (FIGS. 1A-1C). The encasing unit **201** differs from FIGS. 1A-1C in particular by a different cross-sectional shape of the fixing profile **222** in the second functional region **220**. The fixing profile **222** in FIG. 2 is of a positive shape or is a male positively locking portion with a cross-section for example of T-shape except for the interface or opening **213** and corresponding to the cross-section of the first functional region **210**. Thus the encasing unit **210**, in relation to both longitudinal central planes, vertically and horizontally in FIG. 2, is of a substantially symmetrical cross-section, except for the opening **213** at one side. Corresponding symmetry is also desirable for uniform torsion-free flexing in the direction-changing arc **4** (FIG. 8). Alternatively the second functional region **210** could be identical to the first functional region **210**, that is to say fully symmetrically with an opening **213** at both sides. In that case the encasing unit **201** would be composed of two structurally identical half-shell portions (not shown) which can be produced for example by injection moulding processes.

In addition the encasing unit **201** permits separation without opening the adjacent encasing unit **201**. That is achieved by fixing of adjacent encasing units **201** (FIG. 1C) in each case by means of a separate fixing bar **204**. The fixing bar **204** is of a symmetrical cross-section which is uniform throughout, for example of a H-shape or a double C-shape. At both sides the fixing bar **204** has an internal contour **223** matching both functional regions **210**, **220**, here in the form of a negative shape or a female positively locking portion. The fixing bar **204** can releasably connect two encasing units **201** by positively locking engagement and/or force-locking engagement, as FIG. 2 shows. At the same time the fixing bar **204** together with the functional

region **210** serves as a closure for dust-tightly closing the opening **213** between the closure profiles **211**, **212**. Other cross-sections, in particular of the functional regions **210**, **220** and the fixing bar **204**, can also suitably embody the principle shown in FIG. 2.

FIGS. 3A-3B show a further advantage of the symmetrical structure of the encasing unit **201** in FIG. 2. It is possible to mount laterally to the outer encasing units **201**, that is to say the narrow sides of the encasement **200**, a respective structurally identical support device **240** for supporting and definedly guiding the encasing units at the functional regions **210**, **220**, as shown in FIG. 3B. For that purpose the support device **240** has a carrier band **244** of a cross-section corresponding to the fixing bar **204**, that is to say matching the cross-section of the functional regions **210**, **220**, for example grooves on both sides with an internal contour **223**.

The support device **240** is designed to predetermine the radius of the direction-changing arc **4** (see FIG. 8) and to support the self-supporting run **1** in the straight position, or to increase the possible length of the run **1**. For that purpose the support device **240**, transversely to the longitudinal direction L, has on both sides T-shaped abutment elements **245** which are formed with the carrier band **244** and which are perpendicular thereto, with T-arms **246**, **247** disposed in the longitudinal direction L of the encasement **200**. The upper/lower or inner/outer T-arms **246**, **247** are of different lengths so that the T-arms **247** in the direction-changing arc **4** abut radially inwardly at the desired radius and the T-arms **246** are in abutment in the straight position. The carrier band **244**, like the fixing bar **204**, is preferably disposed at the level of the neutral fibre of the flexible encasement **200**. The fixing bar **204** and the support device **240** are made from flexible, flexurally elastic plastic or plastics. They do not rub against the lines and if required can therefore be of greater flexural strength than the encasing units **201**, for example to maintain a radius in the direction-changing arc **4** or to increase the self-supporting run length. Further details relating to the configuration of the support device **240** can correspond to the teaching of WO 2008/125087 A1, except for the configuration of the carrier band **244**.

In FIGS. 1 and 2 each encasing unit **101**, **201** respectively forms precisely one receiving means **102**, **202** for one or possibly a plurality of lines. FIGS. 4 to 6 show embodiments in which the encasement **101** respectively has a one-piece encasing unit **401**, **601** with subdivisions for forming a plurality of parallel receiving means **402**, **602** in the same encasing unit **401**, **601**.

FIGS. 4-5 show an alternative one-piece encasing unit **401** having for example three parallel receiving means **402** which can be respectively individually opened (FIG. 4A) and closed (FIG. 4C) to replace or introduce lines. The encasing unit **401** is designed in one piece in the form of a flexible plastic profile with a cross-section which remains the same throughout in the longitudinal direction L, as shown in FIG. 4. It can be manufactured for example from one piece by extrusion. Advantages in respect of manufacturing technology and in relation to material can be achieved if the functional regions, in particular closure profiles **411**, **412** are produced separately and possibly from particularly suitable different plastic and are subsequently joined in one piece to the wall regions. It is also possible to envisage a multi-component manufacturing process.

At the narrow sides the encasing unit **401** has two functional regions **420**, **421** which are in opposite relationship at both sides and with which adjacent encasing units **401** can be connected to each other in parallel, as shown in FIG. 5. The functional regions **420**, **421** in FIGS. 4-5 have

fixing profiles **422**, **425** which are in one piece with the encasing unit and which are adapted for positively locking and force-locking relationship with a cross-section interengaging in conjugate fashion, for example similarly to FIG. 1. The fixing profile **425** at the side to be opened is designed in two parts with an intermediate interface, for example similarly to the functional region **110** in FIGS. 1A-1C, with an external contour matching the internal contour **423** of the fixing profile **422**. Alternatively fixing by means of separate fixing bars, similarly to FIGS. 2-3, is also possible.

As FIG. 4A shows in greater detail at one side of each of the plurality of receiving means **402** of the same encasing unit **401** a respective functional region **410** is connected in one piece to the encasing unit **403** with an oppositely disposed pair of cooperating closure profiles **411**, **412**. The closure profiles **411**, **412** also extend in the longitudinal direction L with a uniform cross-section and serve for sealingly closing (in relation to particle size) the respectively associated receiving means **402** (FIG. 4C). The closure profiles **411**, **412** can be in the form of a closure bar including at least profile elements **414** which engage into each other in positively locking relationship, for example with a barb shape in cross-section, on the principle of a suitable pressure closure, or the like. Support regions **415** serve for positively locking latching of the profile elements **414** in the closed state (FIG. 4C). By means of associated closure profiles **411**, **412** the receiving means **420** can be individually opened and sealingly closed as required. Opening can be effected by bending open the flexible wall region **403**. FIGS. 4-5 show a functional region **410** which is in the form of a robust double closure respectively comprising two profile elements **414** at each closure profile **411**, **412**, for example to exclude unwanted opening in operation. Unwanted opening however can already be avoided if the wide side to be opened of the encasement **400** is disposed radially inwardly in the direction-changing arc **4**. The interface of the opening **413** between the closure profiles **411**, **412** is arranged at the level of the neutral fibre, see FIG. 4C.

FIG. 5 shows an encasement **500** comprising two encasing units **401** which are fixed to each other releasably and parallel by means of their lateral functional regions **420**, **421** or their fixing profiles **422**, **425**. A respective support chain **135**, as described in relation to FIG. 1A, can be arranged in the two laterally outer receiving means **402**, for example when a great length is involved.

FIG. 6 shows a variant in relation to FIGS. 4-5 having an encasing unit **601** which has only one closure for all receiving means **602** jointly. For that purpose there is provided only one functional region **610** with cooperating closure profiles **611**, **612** at a narrow side. The wall regions **603** are designed to be connected together plate-like at both wide sides of the encasing unit **601**. Otherwise the encasing unit **601** corresponds to the encasing unit **401**.

FIGS. 7A-7B show a further preferred embodiment of an encasement **700** which is made up of a multiplicity of individual, structurally identical encasing units **701** which respectively form precisely one receiving means **702**. In contrast to FIGS. 1-6 the encasing units **701** are closed in the longitudinal direction L and in the peripheral direction, that is to say with an encasing wall **703** which extends without interruption around the receiving means **702**. The wall **703** is for example in the form of a tube or a hose or the like of approximately oval or round cross-section. The encasing units **701** are at least predominantly made from flexible, permanently elastically bendable plastic.

The encasing units **701** cannot be non-destructively opened, that is to say lines have to be passed therethrough

axially or in the longitudinal direction, unlike FIGS. 1-6. Unwanted discharge of particles during maintenance operations can be avoided in that way. A simplification in maintenance and expandability is achieved with the encasing units **101** without a closure function at the receiving means **702** solely by the concept of the fixing function or only functional regions **720**, **721** cooperating for parallel fixing of individual encasing units **701**.

Each encasing unit **701** as shown in FIGS. 7A-7B has functional regions **720**, **721** which are produced at both sides in diametrically opposite relationship with the closed encasing wall **703** or subsequently connected thereto and extended in the longitudinal direction L. The functional regions **720**, **721** respectively have as the fixing strip a fixing profile or a fixing bar for releasable connection by positively locking engagement and/or force-locking engagement. The functional regions **720**, **721** are adapted to cooperate, for release or fitment of an encasing unit **701** from or to an adjoining encasing unit **701** as required. FIG. 7B shows by way of example two connected encasing units **701**. It is possible for example to use fixing profiles as functional regions **720**, **721**, which are of a uniform cross-section in the longitudinal direction to permit extrusion. The functional regions **720**, **721** here too extend in strip form in a plane in opposite relationship at two sides along the wall **103**. The fixing strips of the functional regions **720**, **721** can be in the manner of a toothed zip closure, a toothless sliding closure or the like. The functional regions **720**, **721** cooperate for fixing purposes, possibly also with a separate fixing bar as in FIG. 2, which connects the fixing profiles or fixing bar. FIG. 7B diagrammatically shows a closure slider **750** for connecting/separating functional regions **720**, **721** which, for fixing the encasing units **701**, purely by way of example, are for example in the form of positively locking toothless sliding closures. The functional regions **720**, **721** can be produced separately, for example by extrusion or injection moulding, and can be integrally connected to the remaining profile of the encasing units **701**, for example they can be welded in place continuously in the longitudinal direction using a suitable procedure. Preferably for that purpose the encasing wall **703** and the functional regions **720**, **721** are made from a thermoplastic material.

Adjacent guide channels or receiving means **102** . . . **902** are accordingly fixed to each other by band-like intermediate regions which have a functional region at least at some receiving means **102** . . . **902** that simplifies maintenance and/or facilitates a subsequent modification in the encasement.

The flexurally elastic encasing units **101** . . . **901** can be produced in a unitary material from only one plastic material, in particular in a multi-part configuration comprising separate regions which are then connected in material-bonded relationship, in particular being welded together. The encasing units **101** . . . **901** can possibly be produced in a multi-layer structure or with a coating, for example with an external special plastic for reducing friction at the wide sides.

FIG. 8 diagrammatically shows a configuration of a dynamic line guide with dust-tight encasement **100**, for example as shown in one of FIGS. 1 to 7, forming a moveable upper run **1** and a stationary lower run **3**. Between them the encasement **100** forms a direction-changing arc **4** with a predetermined bending radius about a notional axis A. The direction-changing arc **4** travels over a distance relative to a stationary connection **5** when the upper run **1** is displaced with the moveable connection **7**. Any position in space however can be involved here, and the encasement

100 can also move vertically or laterally. The two ends of the encasement 100 are dust-tightly closed, for example with clamping devices as shown in FIG. 1A. The encasement 100 is overall of a hose-like configuration and is sufficiently flexible, inter alia by virtue of being of a suitable configuration and/or by a suitable choice of material, to allow reversible flexible curvature of the direction-changing arc 4 with a small amount of applied force, and to follow the travel movement of the moveable connection 7 with the lowest possible level of resistance.

FIGS. 9A-9D diagrammatically shows an encasement 900 which is made up of a multiplicity of individual encasing units 901. The encasing units 901 each form one or more receiving means 902. In contrast to FIGS. 1-6 the encasing units 901 are closed in the longitudinal direction L and in the peripheral direction, that is to say, being designed with an encasing wall 903 which extends without interruption around the one or more receiving means 902. The wall 903 is for example in the form of a tube, a hose or the like, with an approximately lens-shaped or ogival (or vesica piscis/ double-pointed oval) or also oval or round in cross-section. Preferably the lens-shaped cross-section shown in FIGS. 9A-9D is used to provide the receiving means 902. That can be formed in particular from two identical segments of a circle which are assembled at their chords symmetrically relative to the neutral fibre. That cross-sectional shape reduces fold formation, that is to say abrasion in the direction-changing arc. The encasing units 901 are at least predominantly made from flexible, permanently elastic, bendable plastic, in particular being extruded, for example from expanded PTFE.

Encasing units 901 as shown in FIGS. 9A-9D cannot be non-destructively opened, that is to say lines have to be passed through same axially or in the longitudinal direction, unlike FIGS. 1-6. Unwanted discharge of particles during maintenance operations can thereby be reliably avoided. A simplification in maintenance and expandability is achieved with the encasing units 901 without a closure function at the receiving means 902, solely by the concept of the fixing function or the functional regions 920, 921 which cooperate for parallel fixing of individual encasing units 901. In that case each encasing unit 901 can for example have an interrelated line strand in order to renew a line strand prefabricated with plugs or the like independently of a differing line strand, by means of replacement of an encasing unit 901.

Each encasing unit 901 as shown in FIGS. 9A-9D has functional regions 920, 921 which are disposed in diametrically opposite relationship on both sides and which are either produced in one piece with the closed wall 903 or are subsequently connected thereto and which extend continuously in the longitudinal direction L. The functional regions 920, 921 each have as a fixing strip a fixing profile and/or a fixing bar for a releasable connection by positively locking and/or force-locking engagement. The functional regions 920, 921 are adapted to cooperate for detaching or fitting an encasing unit 901 as required to or from an adjoining encasing unit 901. A suitable structure is described herein-after with reference to FIGS. 10A-10D.

FIGS. 9B-9D show by way of example two connected encasing units 901, a first encasing unit 901 forming three receiving means 902. In FIG. 9B a second encasing unit 901 also has three receiving means 902. In FIG. 9C the second encasing unit 901 has two receiving means 902 while in FIG. 9D there is one receiving means 902. A different number of receiving means 902 which are formed by an encasing unit 901 permits adaptation of an encasing unit 901

to a line strand (not shown), in particular to the number of lines (not shown) within a line strand (not shown). Thus a configuration according to requirements of encasing units 901 with an adapted number of receiving means 902 within an encasement 900 makes it possible for an individual line strand (not shown) to be replaced as required by the replacement of an encasing unit 901.

It is possible to use for example fixing profiles as functional regions 920, 921, which are of a uniform cross-section in the longitudinal direction L, to permit extrusion. The functional regions 920, 921 here too extend in strip form in a plane in opposite relationship at two sides along the encasing wall 903. The fixing strips of the functional regions 920, 921 are designed in the manner of a closure with interengaging fixing profiles, similar for example to press-closure bags or preferably zip-closure bags. The functional regions 920, 921 here cooperate for fixing purposes, possibly also with a separate fixing bar as in FIG. 7 which connects the fixing profiles or fixing bar.

Preferably the functional regions 920, 921 are produced in one piece with the walls 903 by extrusion, either using a unitary material or from different plastics, for example with a flexible but stronger or harder plastic for the functional regions 920, 921. The functional regions 920, 921 can be produced separately, for example by extrusion or injection moulding, and can be integrally connected to the remaining profile of the encasing unit, for example being welded continuously in the longitudinal direction by a suitable procedure. Preferably for that purpose the wall 903 and the functional regions 920, 921 are made from a thermoplastic material.

FIGS. 10A-10D show a particularly preferred further example of an encasing unit 1001 representing a variant of the principle shown in FIGS. 4A-4D. In this case also the encasing unit 1001 is made from flexible bendable plastic, preferably by extrusion, and has a plurality of, for example three, receiving means 1002 for lines 6 in the closed state (FIG. 10B). In that case the encasing unit 1001 for each receiving means 1002 has a respective dedicated or associated functional region 1010 which is in the form of a closure, here in particular in the form of a strip-like closure bar with two engagement profiles or closure profiles which engage into each other in conjugate relationship, more specifically a hook profile 1011 which can engage into a claw profile 1012. The hook profile 1011 and the claw profile 1012 are each provided with at least one undercut configuration, preferably two symmetrical undercut configurations, and engage into each other with a barb-like function, that is to say they are relatively easy to close or connect but are to be released only with the application of a markedly greater force.

In addition at both opposite narrow sides the encasing unit 1001 also has a respective functional region 1020 and 1021 which serves for modular fixing of a plurality of encasing units 1001 with correspondingly structurally identical functional regions 1020 and 1021 in a position laterally in mutually juxtaposed relationship or at a support device (see FIG. 3A). The fixing strips or bands 1020, 1021 are here also in the form of a claw profile 1022 and a hook profile 1025 respectively, similarly or identical to the closure functional regions 1010.

FIGS. 10C-10D show diagrammatic enlarged cross-sectional views of the hook profile 1011 and the claw profile 1012 which being of identical structure can also be used for the closure functional regions 1020 and 1021 respectively. The hook profile 1011 and the claw profile 1012 are of a cross-section which remains the same throughout in the

longitudinal direction (perpendicular to the plane of FIGS. 10C-10D) and are in the form of flexible strips or bands which are bendable about the axis A in the direction-changing arc 4 (FIG. 4). The hook profile 1011 is in the form of a symmetrical double-hook profile with respect to the neutral fibre N, for example as shown here of an arrowhead shape, a mushroom shape or the like and has respective correspondingly rear undercut configurations or undercut portions. The rear sides 1027 can extend rearwardly inclined at an angle with respect to the plane of symmetry and the connecting direction in order to enhance the action as a barb and to reliably prevent unwanted detachment. The claw profile 1012 is of corresponding cross-section symmetrically with respect to the neutral fibre N. The claw profile 1012 has an inner receiving means in matching or conjugate relationship with the hook profile 1011 with a matching cross-section and undercut configurations, wherein the receiving means can be designed with an undersize to achieve a force-locking connection. Around that receiving means the claw profile 1012 forms two claw-like bars or strips which engage behind the hook profile 1011 like a jaw and hold it fast. Other forms of a hook profile 1011 and a claw profile 1012 can also be considered, in particular as in the case of toothless zip fasteners, in particular ziplock, sliding or press closures made of plastic. The foregoing configuration can be appropriately used for the fixing functional regions 1020, 1021. Zip fasteners 1010 or 1020, 1021 with interengaging parts which are of a substantially uniform cross-section over their entire length and which are operated without a slider as that structure can be easily implemented using an extrusion process are preferred. It is also possible to provide a suitable slider as a tool or an aid for opening or closing purposes.

An arrangement of the closure functional regions 1010 and fixing functional regions 1020 and 1021 at the level of the neutral fibre N as in FIGS. 10A-10D is particularly advantageous. The neutral fibre N, also referred to as the zero line, is the layer in the cross-section whose length does not change upon bending, in particular upon displacement of the direction-changing arc 4 (FIG. 8), that is to say the layer involving a constant dimension in the longitudinal direction upon curvature.

As is particularly clearly visible from FIGS. 10C-10D the fixing functional regions 1020 and 1021 can be relatively easily connected together in a connecting direction V which is perpendicular to the longitudinal direction L, wherein the connecting direction V can be substantially in the plane of the neutral fibre N. The fixing functional regions 1020 and 1021 however can only be detached with very great difficulty in opposite relationship to the direction V so that unwanted release does not occur in operation.

The closure functional regions 1010 and fixing functional regions 1020 and 1021 can be produced with a unitary material with the walls of the receiving means 1002 or can be produced from a comparatively more flexurally stiff plastic, for example using an extrusion process, for example to increase the stability of the connections and the encasing unit 1001 overall.

FIG. 11 shows a modification with an encasing unit 1101 in which the fixing functional regions 1120 and 1121 are designed in accordance with the principle shown in FIGS. 10A-10D. The closure functional regions 1110 in contrast are in the form of double hook engagement profiles based on the principle of FIGS. 4A-4C. It is to be noted here that the view in FIGS. 4A-4C is not true to scale as the closure functional regions 410 are shown there on a greatly enlarged scale. Typically the functional regions 1010, 1020 or 1021 or

1110, 1120 and 1121 are of a structural height in cross-section in the millimetre range, for example from about 1 mm to about 3 mm.

FIG. 12 again shows a modification over FIGS. 10A-10D with the essential difference that each encasing unit 1201 in FIG. 12 forms precisely one receiving means which can be individually opened and closed. Besides a corresponding closure functional region 1210 with a hook profile 1211 and a claw profile 1212 similarly to FIGS. 10A-10D at each receiving means in FIG. 12 each individual receiving means also has at both sides at each narrow side its own fixing profile, for example a claw profile 1222 or a hook profile 1212.

FIGS. 13A-13C show a diagrammatic enlarged cross-sectional view of variants of the fixing strips with hook profile 1021 and claw profile 1022 in FIGS. 9A-9D or as shown in FIGS. 10C-10D.

In FIG. 13A the hook profile 1321A is substantially T-shaped in cross-section with bevelled rear sides 1327 for achieving a barb function. Only the claw profile 1322A, with a receiving means of a complementary T-shape, has inclined insertion portions 1332 in mutually opposite relationship symmetrically with respect to the central plane which in operation forms approximately the neutral fibre N. By virtue of the inclined insertion portions 1332 the hook profile 1321A is to be connected to the claw profile 1322A with a low force in the connecting direction V, but in the opposite direction can only be released with difficulty. As in FIGS. 9A-9C the individual fixing strips in FIG. 13A are also integrally connected to the walls of the individual receiving means 1302 by way of thinner strip-shaped or band-shaped intermediate regions 1333. The receiving means of which there are optionally a plurality are also connected by way of such intermediate regions 1333, wherein the intermediate regions 1333 contribute to a predetermined position of the neutral fibre N. The connection of the fixing strips or hook profile 1321A and claw profile 1322A is here of a force-locking and positively locking nature.

In FIG. 13B the first fixing strip is substantially in the form of a circular-cylindrical round bar or a round profile 1321B which in the connecting direction V can be easily connected to the conjugate C-shaped and clamp-like second fixing strip 1322B.

In FIG. 13C the hook profile 1321C of the first fixing strip is as shown in FIGS. 9A-9D and FIGS. 10C-10D, whereas the claw profile 1322C is of a differing configuration which however also produces a barb-like function by virtue of inclined rear sides 1327. In FIG. 13C therefore, differing from FIGS. 9A-9D and FIGS. 10C-10D only one of the fixing strips, namely the hook profile 1321C, has symmetrical inclined insertion portions 1332. Otherwise the fixing strips act in a manner corresponding to FIGS. 9A-9D and FIGS. 10C-10D. Further modifications of the cross-sectional shapes of the fixing strips are also possible, as FIGS. 14-15 also show.

FIG. 14 shows a development with encasements 1402 each with only one receiving means 1402 in which closure profiles 1411, 1412 are provided as closure bars, having cooperating profile elements 1414 which engage into each other in positively locking relationship. Those profile elements 1414 are for example of a cross-section in barb form, in accordance with the principle of a suitable press closure or the like, similarly to FIG. 4A and FIG. 6 respectively. By virtue of associated closure profiles 1411, 1412 the receiving means 1402 can here too be individually opened as required and dust-tightly closed for replacement of a line or support chain. The closure profiles 1411, 1412 have a doubled

toothed bar each having two interengaging parallel profile elements **1414** for a secure fixed connection in the closed state of the receiving means **1402** (FIG. **14B**). In addition each encasement **1401** has two cooperating fixing strips or profiles **1421**, **1422**, arranged laterally beside the closure profiles **1411**, **1412** and also extending continuously in the longitudinal direction with a uniform profile. In this case the fixing profiles **1421**, **1422** are of the same structural shape or the same cross-section as the closure profiles **1411**, **1412**. In the example of FIGS. **14A-14B** the encasing wall **1403** can be bent open after opening of the closure profiles **1411**, **1412**. Independently thereof individual encasements **1401** can be connected together or released from each other by way of the fixing profiles **1421**, **1422**. As a deviation from FIGS. **9-10** and FIG. **13** the connecting direction **V** of the fixing profiles **1421**, **1422** is here however directed perpendicularly to the neutral fibre **N**, but is in the plane perpendicularly to the longitudinal direction, as FIG. **14B** shows.

As a variant from FIG. **14** FIG. **15** shows a structural configuration which is comparable in the fitted state and in which each encasement **1501** is composed of two half-shell portions **1503A** which each have two closure profiles **1511**, **1512** and only one fixing profile **1521**. Two connected half-shell portions **1503A**, as shown in FIG. **15B**, are however again coupled to each other by way of two respective lateral, functionally separate fixing strips **1521A**, **1521B**.

In the variant shown in FIG. **16** the closure profiles **1611**, **1612** correspond to those in FIGS. **14-15** or FIG. **4** or FIG. **6**, whereas the fixing strips **1621**, **1622** have the hook and claw profile of FIG. **9** and FIGS. **10C-10D**, which can be fitted together in the connecting direction.

As a possible development, in particular of the closure profiles of FIGS. **14-16** and FIG. **4** and FIG. **6**, FIG. **11** shows an enlarged diagrammatic view of a further functional profile with cooperating functional regions **1711**, **1712** based on the principle of a suitable press or zip closure. In this case the individual closure profile elements **1714** are of identical cross-section, each with a mirror image-symmetrical mushroom head or double T-shape or the like and engage into each other or behind each other in the form of double rows. With such a design configuration separate support regions **415** as in FIG. **4** are not required. The functional regions **1711**, **1712** of FIG. **17**, as shown for example in FIGS. **14-15**, can also be used as fixing profiles.

FIGS. **18A-18B** show various arrangements of encasements with encasing units **901**, for example similarly to FIG. **9**. In FIG. **18A** the two outer lateral encasing units **901** are specifically associated with two diagrammatically shown support chains **135** so that they are replaceable separately with their associated encasement **901**. This also applies to FIG. **18B**, in which case the associated encasements **901B**, for example for robust support chains **135** of larger size, are of a comparatively larger free cross-section than the line-guiding encasement **901A**.

FIG. **19** shows a multilayer structure with a plurality of encasements **900-1 . . . 900-5** in which encasing units **900** according to the invention for example as shown in FIGS. **9A-9D** are used, wherein some encasements **901B** are provided separately for support chains **135**, for example in the lower layer **900-5** which is the inner layer in the direction-changing arc.

What is claimed is:

1. A line protective guide to guide at least one line of a clean room application, comprising:

an elongate flexible encasement which is reciprocatingly displaceable, with a formation of a direction-changing

arc between two runs, and having at least one receiving means to guide at least one line;

wherein each receiving means extends channel-like in a longitudinal direction from a first end to a second end; wherein the encasement has at least one encasing unit forming the at least one receiving means;

wherein the encasing unit includes a first fixing strip at one longitudinal side and a second fixing strip at another longitudinal side;

wherein the first and the second fixing strips are arranged in opposite relationship and configured to be connectable to each other with a releasable connection by positively-locking engagement and/or force-locking engagement in mutually matching relationship and in a joining direction transversely to the longitudinal direction to releasably fix together a plurality of encasing units with mutually matching first and second fixing strips by connection of the first and the second fixing strips in the joining direction transversely to the longitudinal direction; and

wherein the first and the second fixing strips are respectively in one-piece with the encasing unit.

2. The line protective guide according to claim 1, wherein the encasement includes a plurality of separate encasing units and each encasing unit of the plurality of encasing units has two fixing strips which are in opposite relationship on both sides and which are in one-piece with the encasing unit; and

wherein adjacent encasing units of the plurality of encasing units are connected together in parallel relationship by the fixing strips and provided at the first and second end is a respective clamping device, with which the plurality of separate encasing units of the encasement are respectively secured at the end.

3. The line protective guide according to claim 2, wherein provided in a receiving means of at least one encasing unit of the plurality of encasing units is a support chain to support the encasement upon displacement.

4. The line protective guide according to claim 2, wherein each receiving means of the plurality of encasing units has two cooperating closure profiles of a closure for dust-tightly closing an opened state in which the at least one line is introducible into or removable from a receiving means transversely relative to the longitudinal direction.

5. The line protective guide according to claim 3, wherein each encasing unit of the plurality of encasing units is of a one-piece configuration, forms a plurality of parallel receiving means and provided for each receiving means is a pair of cooperating closure profiles in one-piece with the encasing unit.

6. The line protective guide according to claim 1, wherein each receiving means is of an elongatedly round or oval, with an ogival cross-section and a respective fixing profile as the fixing strip is provided at each narrow side of the encasing unit, in one-piece with the encasing unit.

7. The line protective guide according to claim 1, wherein the encasement includes a plurality of separate and peripherally closed encasing units, wherein each encasing unit of the plurality of encasing units respectively forms precisely one receiving means and each encasing unit of the plurality of encasing units has two fixing strips which are in opposite relationship at both sides and which are in one-piece with the encasing unit.

8. The line protective guide according to claim 1, wherein the at least one encasing unit comprises a plurality of encasing units, each encasing unit of the plurality of encasing units is of a cross-section which remains a same in the

longitudinal direction, wherein the first and the second fixing strips are of a cross-section which remains a same in the longitudinal direction, with an interengaging hook and claw profile.

9. The line protective guide according to claim 1, wherein the receiving means are connected together in parallel relationship by strip-shaped intermediate regions which predetermine a neutral fibre and the first and second fixing strips or profiles are disposed at a level of the neutral fibre of the encasement.

10. The line protective guide according to claim 9, wherein a thinner strip-shaped intermediate region is provided between each fixing strip and an adjoining receiving means.

11. An encasing unit of plastic of an elongate flexible encasement of a line protective guide, comprising:

wherein the encasing unit forms at least one receiving means to guide at least one line, which extends channel-like in a longitudinal direction from a first end to a second end;

wherein the encasing unit includes a first fixing profile at one longitudinal side and a second fixing profile at another longitudinal side;

wherein the first and the second fixing profiles are arranged in opposite relationship and are configured to be connectable to each other with a releasable connection by positively-locking engagement and/or force-locking engagement in mutually matching relationship and in a joining direction transversely to the longitudinal direction to releasably fix together a plurality of encasing units with mutually matching first and second fixing profiles by connection of the first and the second fixing profiles in the joining direction transversely to the longitudinal direction; and

wherein the first and second fixing profiles are respectively in one-piece with the encasing unit.

12. The encasing unit according to claim 11, wherein the first and the second fixing profiles are configured in mutually congruent relationship and of a cross-section which is a same throughout in the longitudinal direction, that cooperate in mutually engaging relationship.

13. The encasing unit according to claim 11, wherein the first fixing profile and/or the second fixing profile has at least one inclined insertion portion extending inclinedly relative to the joining direction.

14. The encasing unit according to claim 11, wherein the first and the second fixing profiles are symmetrical relative to a central plane, in particular a neutral fibre, wherein the first fixing profile and/or the second fixing profile have two symmetrically arranged inclined insertion portions.

15. The encasing unit according to claim 11, wherein the first and the second fixing profiles are configured such that, in comparison with a connection of mutually matching fixing profiles in the joining direction, the first and the second fixing profiles are releasable only with a markedly higher application of force in opposite relationship to the joining direction or are releasable only in the longitudinal direction.

16. The encasing unit according to claim 15, wherein the first and the second fixing profiles are of a cross-section with a barb function.

17. The encasing unit according to claim 11, wherein the encasing unit forms a plurality of tubular receiving means to separate guidance of respectively at least one line.

18. The encasing unit according to claim 11, wherein each receiving means has two cooperating closure profiles of a closure, that extend in the longitudinal direction, for dust-tightly closing an opened state in which the at least one line is introducable into or removable from one of the receiving means transversely to the longitudinal direction.

19. An arrangement of a line guide for a clean room application, comprising:

a elongate flexible encasement which is reciprocatingly displaceable, with a formation of a direction-changing arc between two runs, wherein the encasement has a plurality of encasing units which respectively form at least one receiving means, wherein each receiving means extends channel-like in a longitudinal direction from a first end to a second end;

at least one support chain comprising individual chain links, which is configured to predetermine a direction-changing radius of the direction-changing arc and/or to support a self-supporting run in the straight position; wherein each encasing unit has a first fixing strip at one longitudinal side and a second fixing strip at another longitudinal side, wherein the first and second fixing strips are respectively in one-piece with the encasing unit;

wherein the first and the second fixing strips are configured to be connectable to each other with a releasable connection by positively-locking engagement and/or force-locking engagement in mutually matching relationship to releasably fix together a plurality of encasing units with mutually matching first and second fixing strips, and that each support chain is guided in an associated encasing unit which receives exclusively the associated support chain(s) so that with the associated encasing unit the support chain(s) are replaceable separately from the lines guided in the encasement.

\* \* \* \* \*